Regional Climate Scenarios and Projections of Sea Level Rise

Webcast Transcript

January 29, 2013

Contents

Welcome and Introduction

Slide 1 and 2: Introduction Slide

Operator: Good afternoon, my name is Andrea and I will be your conference operator today. At this time I would like to welcome everyone to the Regional Climate Scenarios and Projections of Sea Level Rise conference call. All lines have been placed on mute to prevent any background noise. If you need assistance during the conference please press star zero on your touch dial phone. Thank you.

I would now like to turn the conference over to Ms. Wendy Jaglom, please go ahead.

Wendy Jaglom: Great. Thanks so much. Welcome everybody, thank you for joining today's webcast on Regional Climate Scenarios and Projections of Sea Level Rise. My name is Wendy Jaglom, I work with ICF International and I'm here today to help with the Webcast logistics.

Slide 3: GoToWebinar Software Logistics

So before I hand things over to Joel Scheraga, EPA, I just wanted to go through a few quick GoToWebinar logistics. So throughout the Webcast you will be muted to minimize background noise; however; you will be able to submit questions and comments in writing which I'll go over on the next slide, we do encourage you to submit questions throughout the Webcast for the presenters and if you have any technical issues, feel free to send those in as well.

PDF and audio files of today session will be made available for download in a few weeks and my apologies, but that URL is actually not correct. The file will be put up on EPA's Climate Change Website, and my apologies for that URL.

Slide 4: Questions (GoToWebinar)

Throughout the Webcast if you do have any technical difficulties feel free to contact me, Wendy Jaglom at wendy.jaglom@icfi.com. As I mentioned, if you have a question you can submit it through the GoToWebinar question pane, so you can see the screenshot on the slide, simply enter your question into the pane and hit send.

We will compile questions for our presenters throughout the Webcast and ask them during the question and answer session which will occur at the end of the Webcast and please include the name of the presenter you would like to answer your question so that we know who to direct the question at.

Slide 5: Optional Feedback (GoToWebinar)

And lastly at the end of the Webcast a pop up window will appear when you exit GoToWebinar and we encourage you to take a few minutes to respond to this, to the optional questions and

provide your feedback, it'll help us make better Webinars in the future. I think Joel will say a few more words about that. And so with that I'll pass it over to Joel.

Slide 6: Regional Climate Scenarios and Projections of Sea Level Rise: Welcome and Introduction

Joel Scheraga: Thanks very much, Wendy. And good afternoon everybody, I'm Joel Scheraga, I'm EPA's Senior Advisor on Climate Adaptation and I want to welcome all of you to today's Webcast.

As most of you on the line today probably know, the U.S. Global Change Research Program released the draft 2013 National Climate Assessment just over a week ago and as part of the activities surrounding the National Climate Assessment, a set of regional climate scenarios, as well as global sea level rise scenarios were produced and this really is a landmark event.

These regional climate scenarios that are now available to all federal agencies from the USGCRP are in fact the first standardized set that the USGCRP has made available that can be used by all federal agencies as they anticipate and prepare for a climate change.

Here at EPA as our program and regional offices are beginning to integrate and mainstream climate adaptation planning into their programs, the one question we have repeatedly heard from our staff over the last few months is what should we be planning for, and the purpose of today's Webcast really is to begin answering that question for you.

I want to note that this Webcast is being jointly sponsored by EPA and the USGCRP and I want to personally acknowledge and thank our Office of the Air and Radiation for helping to actually make this Webcast happen. We're also pleased to welcome colleagues from the Department of Interior to the Webcast today, so welcome aboard everybody.

I'm also pleased to say, and you see this up on the slide, I'm also pleased to say that this Webcast is supporting the efforts of the Interagency Adaptation Planning Work Group that is part of the White House climate change adaptation task force. That Work Group has been charged by the Council on Environmental Quality at the White House, we're partnering with the U.S. Global Change Research Program to begin to bridge science and policy in the area of climate adaptation, so this supports that effort.

And finally as Wendy alluded to you, I want to note that this is a pilot effort, this is a pilot Webcast, and if there're a few listening in who find it useful for the work that you're doing, the USGCRP may in fact offer similar Webcast to other federal agencies, so in some ways we're the guinea pigs.

Slide 7: Regional Climate Scenarios and Projections of Sea Level Rise

Going to the next slide as Wendy mentioned, we are taping and transcribing this Webcast, and all of the information that you will see today is in fact going to be made available to you on EPA's Climate Change Web site following the Webcast, and we will get that URL to you.

Since this is a pilot effort, I do want to reemphasize something Wendy requested. Your feedback really is going to be invaluable to us so I really like to encourage all of you, if you can take a few minutes at the end of the Webcast to fill out the voluntary exit survey that will pop up on your screen to give us a sense for what worked and why and perhaps what we could do better.

And finally I want to note a very special effort that the USGCRP is doing on our behalf. You're going to be hearing a couple case studies from Ken Kunkel today to illustrate the type of regional climate information that is available in the northeast and the southwest.

If any of you have already looked at the documentation that was passed on to you, you will notice that the existing documentation on the regional climate scenarios is very technical and very detailed. And consequently the USGCRP has agreed to produce over the next couple of weeks one-page summaries that make this information a lot more accessible and transparent to you as the users. We really want to make this information user-friendly.

And again these one pagers will also be sent to you in the near future, so we'd hope for example that they'll be provided in a timely and useful way, so that those of you for example in the northeast who are involved in the Hurricane Sandy recovery efforts could use this information to perhaps begin to integrate climate adaptation planning into those recovery efforts.

Slide 8: Webcast Agenda

Going to the next slide, I just wanted to show you very quickly the agenda. We're going to start out with a presentation by Anne Waple, introducing the work that's been done as part of the National Climate Assessment and the work that's been done on these Regional Climate Scenarios.

We'll then head it off to Ken Kunkel who is one of the architects of this work, who will present the two case studies for the northeast and the southeast; again to give you a better center how to actually use this information.

And last but certainly not least, our colleague, Adam Parris is going to discuss the sea level rise scenarios that are also now available for you to use and even better, Adam is going to provide us with insights about ways in which these scenarios should be used and he's even going to discuss some of the tools that are already readily available to you for doing that work.

And then as Wendy said, we're going to end it with a lengthy Q-and-A session, we'll hold all questions to the end but we want to make sure that we're answering the questions that are foremost on your minds. So now I want to remind you, please as questions come up type them in and please identify the person you would like the question to go to and we'll come back to those at the end.

So without further ado, I'm going to hand it off with Anne Waple, and once Anne is done I'll introduce Ken Kunkel.

Dr. Anne Waple is the NOAA Assessment Program Manger, and she is currently the Chair of the Technical Support Unit for the National Climate Assessment. Anne is a busy person; she also co-chairs the development of the Global Change Information System and is the Vice-chair of the Interagency National Climate Assessment Work Group.

I've known Anne for many years, she's worked in NOAA and the USGCRP for over 11 years and she's got a wide range of expertise, she's worked on issues ranging from climate monitoring to marine climate data management, and in fact she has been working on the National Climate Assessments since 2009. So without further ado, let me hand it over to Anne.

Overview and Use of the Regional Climate Scenarios

Slide 1: Introduction Slide

Anne Waple: Thanks, Joel. And thanks everyone for joining. I see lots of participants on the call and so this is a great opportunity for us to talk about the scenario, and we're really looking forward to all of the feedback, and personally, and I think on behalf of everybody, we're hoping that this is not the end of a conversation but very much the beginning of the conversation about this.

And I want to echo something that Joel said, that we're really at the beginning of this process for a number of different reasons, and it would be really great for us to hear back from you to both improve the way that we communicate about this with you via Webinars or other means, but also where we take this effort in the future, and really I think there're a number of different pathways that we could take that is useful for both an assessment process as well as directly useful for people like yourselves who are making use of this information every day.

So very pleased to be able to talk to you today and looking forward to your feedback. All I have is just a few slides really to introduce the whole efforts to you, and then Ken and Adam will talk about the hard work that they've been doing to actually put this all together.

Slide 2: Scenarios and the National Climate Assessment

So as a bit of background, the way that this effort started out, in planning for this new National Climate Assessment, and as you may be aware, we've had a couple of previous National Climate Assessments, one in the year 2000 and one in 2009.

And we're very report focused, we've produced synthesis reports that were distributed around the country and they were made use of in various ways, but we wanted to make sure that in this National Climate Assessment, that we had the beginning of a more sustained approach and one that rested on something we could really build in the way of rigorous processes, repeatable process, traceable information, and so on.

And so one of the discussions that we had quite early on in the process was about the use of scenarios, and there's always discussion in the assessment arena about how to use scenarios, what we should use, how should we talk about the future. And so this is a very important and timely effort and I think we're looking forward to building on it. So we really had this emphasize trying upfront on the need for risk based and durable scenario processes that we could build over time.

And the Federal Advisory Committee for the National Climate Assessment, the short-named NCADAC initiated discussions for how best we could go about this, and so what you're seeing now is a beginning and outcome in the early part of process that is being used in the National

Climate Assessment, but also we have to build it so that it's of even more direct benefit to decision makers like yourselves in the near future.

And just outside again, of course, this isn't evolving yet and so we're looking forward to your feedback.

Slide 3: The "New" National Climate Assessment

So the National Climate Assessment is a little bit different than what we've done in the past , we have an explicit emphasis now on making it an inclusive process, so with lots of partners and stakeholders involved in the production, as well as the use of this National Climate Assessment.

And we're looking at it in a more of a risk based vulnerability kind of assessment way, and so not only do we want to say something about the state of the climate science, but we also want to talk about the anticipation of impacts, and the mitigation and adaptation of climate change and its impacts as well, so a very sort of explicit goal.

Slide 4: Goals for the NCA

Specifically when we get to some of the goals, we want it to be sustained, a very durable process. We want it to be ongoing and not just focused around these periodic reports. Relevance obviously comes a lot from the engagement of stakeholders, and of course we wanted to reflect the basis of assessments which is this highly credible, authoritative kind of process and so that isn't changing but we're actually helping to improve that as well.

We want it to be a little bit more timely, and that's also one of the reasons we're focusing on scenarios because not only will it provide input to periodic synthesis reports, but as a standalone set of products and services they will be more useful to tapping into directly and not waiting for these periodic reports.

And we want to build in this systematic and ongoing evaluation of how we're doing in response to climate change, what are the risks, how are they changing, the vulnerability and how it's changing and how we're making progress towards reducing all of that.

And finally on this slide there are a set of national indicators that are being put together as part of a large program of effort that we're hoping people can look at between a synthesis report, sort of like in the dashboard feature or something like that, so they can always see what's changing and that's a big project that's just getting on the way right now.

Slide 5: Goals for the NCA

So I mentioned that this will be a sustained process, it will inform our research program as well as being directly useful now. The scenarios are really a key component to this, and I want to emphasize that it's not just of the national scale with the National Assessment, but we have eight regions in the U.S., and we certainly want to make sure that we're building it in such a way as

people can plug in to these scenarios at whatever scale we have made available, but perhaps build on that at smaller scales or a larger scales as it makes sense.

We want to be able to evaluate our adaptation and mitigation options and how we're doing with that, we certainly want the assessment to be part of a community building enterprise; I think the scenarios are actually a very important component to that as well.

Scenarios from my perspective are not just about providing climate information in a neat package but also building in the social needs, the societal, economic and other needs of the decision makers in the process and I'll mention that in a second.

And then building the foundation for adaptation networks, this is sort of regionally focused probably, and it helps to apply the assessment information that we feel is very much between the science and the services, and making that connection is very important at the regional scale.

Slide 6: Scenarios of the Future

So speaking up specifically on these scenarios, these are the four areas in which we've discussed scenarios at this point through the National Climate Assessment, and the two that we'll talk about today are climate and sea level change, and primarily because those are the ones that we've had to do the most work on, there are land use scenarios out there and they bring together information that's already available.

Socioeconomic scenarios, we've done less work on and need to do more, and we really hope as I mentioned just a second ago to include some participatory scenario planning into this, where it's the result of a conversation and not just pushing climate information in one way direction.

Slide 7: What are Scenarios?

So climate and sea level change will be the ones that we talk about today. So I think probably most of you on the call are familiar with this but just in case, just to make it clear that when we're talking about scenarios we're not talking about prediction or a forecast for the future. What we're talking about today are a couple of different future conditions primarily that we're hoping we'll provide a good basis for an assessment of risk and vulnerability of regional scales, and also at national and global scales.

So these are snapshots essentially of a couple of alternative futures, maybe more against which planning can occur. So the possible reason that we think, you know, it's very possible that we would end up close to one of them but they're not predictions of any sort. They can be very quantitative, they can also be just descriptive, here we've got sort of a mix of the two.

But they're based on quantitative assessments of future emissions, and all future scenarios have a wide range of assumptions that are used in order to even pick any sort of future scenario. So any one of these has an uncertainty with them, and obviously we are just sort of looking from a risk based approach in terms of what if scenarios so that we can plan around them.

Slide 8: NCA Scenario Development

For the National Climate Assessment, the way that we went about looking at scenarios was, we had a Central Advisory Committee as I mentioned the NCADAC, they convene the subgroup or working group to try to figure out what to use.

For the future scenarios in the National Climate Assessment, they base them primarily around two greenhouse gas emission scenarios which have been used many times before, they're titled B1 and A2 and they come from the international assessment process, the IPCC, and in this graphic, it's that bottom blue line and the higher yellow line.

And I do want to stress by making sure that you can see all of these other lines, they're not the highest or the lowest set of emissions that we could possibly have by a long shot but they are too upper and lower emission scenarios that might help balance some reasonable future scenarios.

Slide 9: NCA Scenario Development

This is what the temperature looks like for the U.S. based on a bunch of scenarios, again, the A2 is the dashed red line at the top and the B1 is the dashed turquoise line at the bottom. So you can see there're a lot of other scenarios that we could use that will be higher and lower, and I'm showing this primarily to show you that the A2 and B1 is based on a set of assumptions or a set of scenarios that were put together quite a long time ago, and there were some new ones developed fairly recently and we're beginning to start to use those in the National Climate Assessment, and so you may start to see some updates in the next year or so based on these emission scenarios, but none of them are hugely different from each other.

And so we spend quite a bit of time working with the agencies, working with partners across the country, experts of all sorts to produce sea level rise and climate scenarios with these emissions in mind, and you'll all see that this is a highly collaborative effort.

It is initiated by the National Climate Assessment but it's taken on its own life force, and I think everybody recognizes that potential value and we were frankly shocked to that nothing like this has been done before to support decision making or the National Climate Assessment.

Slide 10: Scenario Resources

So as Joel said it, it is sort of a landmark event but it's also right at the beginning of that and so we're looking forward to seeing where this goes. So where can you find all of these great scenarios? You can find access to all of the ones that I mentioned before including sea level and climate at scenerios.globalchange.gov and I want to show you that in just a second.

As with everything because we want to put this out there as soon as we have something reasonable, the resource pages themselves have been put together relatively rapidly, and so we want to evolve this resource, the actual technical Web site and resource to be the most useful for people and I expect it to look quite a bit different a year or two from now than it does at the moment.

But what we started is at least provide all of the graphics in high resolution so you can download them, some information about the graphics as much metadata for example as we can find on each one, and we're going to start to provide some data, maybe some GIS layers, other types of metadata, and we'd be very interested to hear what your priorities would be in terms of making the most use of these scenarios, and of course you'll be able to see the reports themselves there.

I also want to point out this e-mail address at the bottom, if you do have any questions for the GCRP about the scenarios you can use that e-mail address, we're monitoring it. Do give us a little bit of time to respond based on the number of questions we get, but hopefully we'll get to your questions.

So I just wanted to quickly show you the Web site, this is scenarios.globalchange.gov, it has a little bit about the scenarios, a little bit about the National Climate Assessment, we'll have some announcements on the left hand side as updates or whatever come into being, you can subscribe to updates as well and we will automatically let you know if things change, you can provide comments and feedback via the Web site.

You can get to the National Climate Assessment or the GCRP as well. If you go to the scenarios tab at the top, we have a description about what scenarios are and which ones we've used, and a description about all of the different pieces of the scenarios that we're trying to put together for the National Climate Assessment and more broadly.

So you can click on climate here for example, or you can always go to these, browse scenarios on the right hand side and just click on climate, a description about what we did, what Ken did, and his team, to put together the climate scenarios, huge amount of work went into this.

And there's also some guidance for use here, about what it really means to use these scenarios and how we'd recommend that you don't use them, and then access to all of the reports themselves. So each of these reports is quickly findable here, you can also go straight to the images if you want to.

And in the images tab, it's got a list of all of the images that we used in the reports and you can search by whether they were the climate, the observed climate or whether they were modeled data. You can search by temperature or tornadoes or whichever kind of keywords you want and you can get your information about the image.

If you click on the title it gives you a lot of information about the images including the files, and if you want to click on the metadata file you have even more information about this, and as I said we're hoping to build on this considerably over time so that you can get the most value out of the production of this information.

You can also go directly to the regions, and so you can just click to your region of interest and be taken directly to the report and all of the images for that region as well. So this is a resource that we hope will be of value now, but we also hope that we're going to add some data to it and some GIS and whatever is useful, so please do let us know about that.

And I think with that I'm going to leave it there and hope that I can answer some questions at the end, and I also want to say that Adam and Ken have gone through quite the process in putting all of these together. I think because it's the first time that we've really done all of these, and we're trying to figure out at the same time how we want to present the scenarios, who we want to be involved, how it should come through the GCRP and the NCA, there's a lot to figure out and they are heroes to have put all of these together, and I think it looks a lot easier than it has been, so I just want to say thanks to them before handing it over to them to explain what they did. Thanks.

Joel Scheraga: Thank you very, very much, Anne, for that terrific overview and I think people can already see that there's just a rich trove of information here that's already available, and again, kudos to all of you for producing that information and there's a lot still coming and a lot of what will come depends on the feedback that we get from people starting today. So again, Anne, thank you.

I'd like to remind folks that if they have questions for Anne and some have already begun to come in online, but if you have questions please type them in and identify that they're for Anne and we'll be sure to come back to them at the end of the call.

Northeast Regional Climatology and Outlook

Slide 1: Introduction Slide

Joel Scheraga: I'd like to now introduce Dr. Ken Kunkel. Ken is with the NOAA Cooperative Institute for Climate and Satellites. Ken has been doing a ton of research on climate variability and change for a number of years. His research has particularly related to extreme events such as heavy precipitation, heat waves, cold waves, and winter storms, and a real particular interesting focus of Ken's work has been the historical variations in the frequency and intensity of such extreme events extending all the way back from the late 19th century to the present, so Ken has done a lot of work in this area, he's been the lead officer on a number of several reports from the U.S. Global Change Research Program.

For example, he was the lead officer on a report on weather and climate extremes in the changing climate, and he is also the lead officer on a report on climate models that assess the strengths and weaknesses of different models. And as I mentioned earlier, and Anne mentioned, Ken is one of the people who helped produce these regional climate scenarios. So without further ado, let me turn it over to Ken.

Ken Kunkel: Thank you, Joel. Hope you can hear me, if I'm speaking too softly or too loudly let me know. Yes, so let me jump right in to the northeast scenarios document, and I picked out some representative samples of the products there, these are for the northeast and I'll go on to the southwest as a contrasting climate in the – at least continue as you asked.

Just a little bit of background, the documents that we produced here were a collaborative effort of many people, on here I've listed my co-authors on this particular report. If you looked at all of the reports together, there's about three dozen separate authors who contributed and there were a number of other people who made the other contributions who are not listed as authors.

Slide 2: Regional Climatology Content

OK, so the documents are really two part documents, they consist of a description of the historical climate conditions that sort of set the foundation or the environment for what could happen in the future with these scenarios, and then we have a whole section of each of these documents on the future conditions that are associated with these particular A2 and B1 scenarios.

So the first part, the regional climatology, the historical parts of these documents are really in three parts, we have general description of the climate of the region, and we talked about some of the major climate factors, sort of the climate hazards that these regions experience. And then we show trends and a number of climate variables and I'll show some examples for those.

Slide 3: Data

For the trends that we show, much of the analysis is based on data from the National Weather Service Cooperative Observer Network, a very valuable network. If you're not familiar with it, it started in the late 19th century in operation, it includes daily observations of precipitation, temperature, and snow.

The major advantage to this network is that first of all, it's operated by the National Weather Service with fairly common and consistent observational techniques and instrumentation through the years, and also fairly dense observations that are available.

Slide 4: Annual Temperature Pattern

OK, well, just to show you a few background slides here, this is the map showing the northeast region and it shows mean annual temperature for the region. If you look at this, of course the northern parts are cooler and the southern parts are warmer, basically we have a range of upper 50s down to 30s for the average high temperature about a 20 degree range from south to north across the region.

Slide 5: Annual Precipitation Pattern

This map shows the annual precipitation for the region, a fairly wet, this is a wet region as everyone of course knows, most areas, they are receiving upper 30s or more precipitation per year, quite a bit of spatial variability and most of that is associated with topography or proximity or lack thereof to the coastline where the moisture source is.

Slide 6: Important Climate Factors

OK, what kind of climate hazards does one experience in the northeast? This isn't necessarily in order of importance but floods are quite widespread, east coast winter storms are more colloquially known as Nor'easters, in the western parts of the region and along the great lakes, lake effect snows a real important phenomenon, severe ice storms have affected the region from time to time.

Heat waves are a real hazard, particularly in the urban areas where there's high population density. Droughts are, even though this is a humid wet region, droughts from time to time can cause some real problems, and tropical cyclones are another one of those real hazards the region has experienced in the last year or two with some major flooding events caused by tropical cyclones in the northeast.

Slide 7: Initial Trends in Precipitation

OK, so let me show you some trends. This is the annual precipitator or the annual precipitation for the year as a whole and that's on top, and then for each of the four seasons with blue being winter; green, spring; red, summer; and orange, fall.

And if you look at the upper panel, lots, I mean, the biggest characteristics about precipitation, and which is true for all the regions to say, is the year-to-year variability. There's a lot of year-

to-year variability. Overlying that though there has been an upward trend in the northeast, more precipitation in the last 30 years or so, 30 or 40 years than there was in the early part of the 20th century.

And what seasons does that occur in? Well, it's primarily a contribution from fall being the most important and then followed by spring. So I think fall has been the main reason why we're seeing an upward trend with precipitation but spring also making a contribution.

Slide 8: Initial Trends in Temperature

Once again we have a time series showing annual on top and then winter, spring, summer, fall in the bottom four panels. And again there's quite a bit of inter-annual variability but a quite significant upward trend in temperature, that's if you look at our long term trend and you look at the last roughly 15 years, none of the years of over roughly the last 15 have been below normal temperatures.

And all seasons' temperatures have been going up, on an absolute magnitude the winter trend is the largest but all of these seasons, the upward trend is statistically significant.

Slide 9: Freeze-Free Season

OK, let's look at some other more detailed feature of the historical climate. This shows the freeze-free season, this is the number of days now between the last occurrence of freezing temperatures in the spring and the first occurrence in the fall.

So if you look at this, what you see for the northeast is actually a little trend over much of the 20th century until you get about roughly around 1990 or so, and since that time there has been quite an upward trend in the freeze-free season, the season is getting longer.

I have seen a linear trend of this although it's really not linear in its characteristics, and if you look at that linear trend it's been about a week until a week and a half over the 20th century, but you noticed in the last five to 10 years, those seasons have been quite a bit longer than would be reflected by that simple linear trend.

Slide 10: Extreme Precipitation (5-yr recurrence)

OK, let's jump into extreme precipitation. In this time series what I'm showing is the number of extreme precipitation events that exceed a five year return period threshold or you could call these five year storms, these are actually 48-hour accumulation.

Again, in this time series lots of variability from year to year, but if you look at the last roughly 15 years there've been a number of years with very high numbers of these extreme precipitation events. As we hit a straight line to it you get to decide an upward trend in the number.

Slide 11: Heat Wave (5-yr recurrence)

OK, heat waves. Here we're looking at a similar kind of a metric where we're looking at a hot spells that exceed again a five year return period threshold, and here we're also looking at a four-day hot spells or four-day periods that are very hot.

A lot of variability which we often see in all kinds of climate time series, the trend here, there is no trend in the northeast. We've had some years that have been very high recently or relatively high, but there were years in the early part of the 20th century which were at a similar level. So we don't see any real trend in heat wave frequency.

Slide 12: Cold Wave (5-yr recurrence)

This is a similar metric for cold waves, again, lots of variability, there is a slight downward trend and if you look at the last 15 years or so, a lot of the years have been quite low, but interspersed with other years that have been relatively high.

Slide 13: Regional Outlooks

OK, now let's jump to the future. As Anne said the NCADAC decided that we would use this A2 and these B1 emission scenarios for looking at the possible plausible futures. And the data that we have used for this, when this decision was made the new data, model data that's being produced for the fifth assessment report of the IPCC was not available and it wasn't unclear whether it would be available in time for use in the National Climate Assessment report.

So we decided to stick with the older data which is known as CMIP3, this is known as the Coupled Model Intercomparison Phase 3 Project. So what we've used for these scenarios is a direct model output from the CMIP3 archive. We've also used a couple of versions of downscaled data or have been downscaled using statistical methods.

Slide 14: Regional Outlook Data Sets

We've also used a set of region of climate model simulations that's known as the NARCCAP suite, this stands for North American Regional Climate Change and Assessment Program, this is a group of six groups that run their regional climate models on the same kind of experimental conditions, and in particular they've all used something close to a 50 kilometer resolution and they've run two 30 year simulations.

One for the historical climate, that's 1971 to 2000 and a future climate scenario 2041 to 2070. So I'm going to really concentrate mainly on the direct CMIP3 archive calculations that we did and then secondarily on the NARCCAP simulation.

Slide 15: Time Periods

OK. Well, for the National Climate Assessment, we decided to produce three or produced analysis of the future for three periods, all of them being 30-year periods. So the first one is a sort of more of a near term period of 2021 to 2050 and this actually represents a 25-year outlook

or 25 years into the future, which is one of the periods specified by the law that mandated that these assessments be done.

We have a middle period, 2041 to 2070 that matches the NARCCAP simulation period and finally we have a period, the late 21st century period, this is actually based on the data availability as close as we can get to a hundred year outlook which is the other extreme mandated by the law that mandated the National Climate Assessment.

Slide 16: Products

OK, we've produced a number of different products; these include maps of the distribution of changes for the future that are means of all models that were used. So we'll call these multi-model mean maps. We've also done some special averaging for the regions to kind of summarize the data and provide sort of an overall picture of what the models produce and we've also produced probability density function showing what the actual distribution of the model output.

Slide 17: Temperature Changes

OK, so let's jump in now for the future projections and we first look at the temperature.

Slide 18: Summary of Model Simulations

OK, first of all this is kind of a summary of the models for the northeast and what these shows are individual models; each point here that's plotted is an individual model for the northeast region.

In red I'm showing what the temperature changes are projected under the A2 scenario, in blue it's the projections under the B1 scenario, dark green shows the NARCCAP projections and that's only for the middle period, that's only the period they ran and finally the lighter green shows the four – the NARCCAP project used four of the GCMs that were used in the CMIP3 experiment and I'm showing that subset of four also.

OK, so there're a few things we can say from this; number one, you compare blue versus green, what you see is that early in the 21st century they're very similar but they've diverged quite a bit by the time you get out to the end of the 21st century. Under the A2 scenario the model's basically produced a rough doubling of the temperature change compared to B1.

The second; a lot of model variability. If you look at again the A2 scenario at the end of the century, temperature change projected by the models ranges from a little less than 5 degrees Fahrenheit up to about 9.5 degrees Fahrenheit so not quite a factor of two but pretty close.

And in fact if you compare A2 and B1 at the end of the 21st century there's a fair amount of overlap among the models, so even though the emission scenarios are quite different, the model differences are also large and so that, you know, there's sort of a comparable amount of

uncertainty associated with the different models as there is with the uncertainties associated with the different emissions path we might follow.

Third point, the NARCCAP models produce quite similar overall temperature changes, they're not producing a different picture in that regard. And final point, there're uncertainties associated with the emission scenarios, there're uncertainties associated with the different models, but the overall picture is unequivocal warming.

All the models are producing very large warming compared to historical variations and it doesn't matter what model you're talking about or what scenario you used. That's a very important point to keep in mind.

Slide 19: Seasonal Temperature Changes

OK, this shows another similar plot but now I'm breaking out through the model results by season, and if you look at that there are some variations among the seasons and we could go into that a little bit, but you stand back and look at the overall picture, the seasonal differences, the differences between seasons is small, quite small compared to the model variation. So I think we can just consider those seasons to be about the same in that sense.

Slide 20: CMIP3, Multi-model Mean Simulation of Temperature Difference (°F) from 1971-1999

OK, let's look at a little bit more here. Now I'm showing maps of the distribution of changes for the northeast and I want to show a lot of these six panel maps, so we have the A2, the higher emissions on the left hand side, the B1 lower emissions on the right, early century on top, mid century in the middle and late century on the bottom.

If you just look at the patterns there are some variations of it regionally, and the distribution there is small comparable to overall changes, but the biggest thing to notice here is that warming is a little less near the coastline than it is in the interior, and that has to do primarily with the moderating effects of oceans. Oceans have moderating effects on temperature and you see it here in this model simulation.

Second thing we showed here is we get an analysis of number one, the statistical significance of the changes from present to future and also the agreement among models in that change, in the statistical significance of the changes. And what hatching means here is that the models all are showing or most of the models in this case are showing statistically significant changes all through the region, and they all are in agreement that the change will be an increase in temperature.

So this indicates high model agreement in this basic signal that we see.

Slide 21: NARCCAP, SRES A2, Temperature Change

OK, let's go on and here I've got some results from NARCCAP and now I'm showing previous results for annual temperature. This also breaks it in by season, you see the seasonal changes in the lower four panels in the middle of the century, this is NARCCAP, so it's the middle part of the century.

And I guess I just like to point out a couple of features here. One, in winter time, there's greater warming to the north and the south; this is part of a global pattern that is in that direction, there's more warming towards the poles and the equators.

In the NARCCAP simulations there's a little less warming in the spring, in the other seasons, but it's relatively small compared to the overall change in temperature.

Slide 22: NARCCAP, SRES A2, Annual Number of Days Tmax > 95°F

OK, now I'm going to step through some derived variables based on temperature and I'll do this fairly quickly but I want to take a bit of time, just so you understand it and then when we go to the southwest I'll probably go through it a lot quicker.

So this shows now the number of days that exceed a 95 degree threshold and in the bottom panel, two panels we show the climatology's kind of the historical number and then in the right panel I show that the number for the future and then the top panel I show the actual change.

So first of all if you look at the climatology you see that in the current climatology these days are rare in the southeast, I mean, the northeast, excuse me, they're not rare in the southeast.

If you look at the right hand panel you see a definite increase in the number particularly towards the south and in fact if you look at it at the top panel and looked at the change, the reddish colors are indicating changes of the order of 10 days or more.

So whereas in the present day climate, we're seeing maybe there's roughly five to 10 days in the south in the future that projections indicate more in the neighborhood of 15 to 20 based above 95.

Slide 23: NARCCAP, SRES A2, Annual Number of Days Tmin < 10°F

OK, this on the flip side. This now shows the change in the number of days that the minimum temperature falls below 10 degrees Fahrenheit, here now as you would expect in the climatology on the lower left of reversed pattern, there's a few of those days in the far south but quite a few days in the, let's say, northern main where you have more than 60 days out there.

The number of days below 10 degrees Fahrenheit drops quite by a large amount if you look at the lower right hand panel, and then if you look at the change on top we're seeing decreases in the order of 20 days or more in the far north in the number of such cold days.

Slide 24: NARCCAP, SRES A2, Annual Maximum Number of Consecutive Days Tmax > 95°F

I'm going to skip over that.

Slide 25: NARCCAP, SRES A2, Length of Freeze-free Season

OK, this is the change in the freeze-free season; we saw that there's been a recent increase in that. The NARCCAP models indicate that under these scenarios we would expect that to continue, we would expect the changes by the middle part of the century under the A2 scenario to be quite large, if you look at the top path you see a lot of red to dark red colors and this indicates changes of 25 days or more, so we're talking about a lengthening of the freeze-free season by that amount.

Slide 26: NARCCAP, SRES A2, Annual Total Cooling Degree Days

OK, so now let's look at a couple other metrics that are related to heating consumption. I'm not sure if everybody's familiar with cooling degree days but this is a metric that's based on temperature but can be related to the demand for cooling, air conditioning in the summer time.

So if you look at the top panel, we'll concentrate from now on the top panel, look at the change in that, we're seeing fairly large changes throughout that, particularly in the south which indicates a substantial increase demand for cooling and these are increase of 50 percent or more across the region.

Slide 26: NARCCAP, SRES A2, Annual Total Heating Degree Days

Heating degree days, this is exactly the opposite kind if metric, it gives you – it's a temperature metric that's related to the amount of energy use for heating during the winter season or the cold season and if you look at the map you see now kind of an opposite pattern where the decreases are smaller in the south than in the north but throughout we're talking about a large decrease in the number of heating degree days, and these represent changes of 20 percent or more in the amount of energy required for heating.

Slide 28: Derived Temperature Variables

OK, these just run down some statistics here on a variety of derived variables including some I did not show and I'll just point out just a couple of these, if you look at, these are averages throughout the region, the number of days above 90 increases by 13 percent, the number of days below zero decreases by 9 percent. Look at the heating degree numbers, those went down a little bit on the percentage.

High average over the whole region, the models indicate a 16 percent decrease on the cooling side, a hundred, basically a doubling of the demand for cooling, of course the northeast is not a region that requires a lot of cooling or it's relatively small compared to other regions in the country, but it's indicating a very large increase in that particular metric.

On the right hand side here just so you know what's in the report, we've also done this with statistically downscaled climate data, and also done the regional averages and without going to

this in detail, most of these are quite similar whether you use NARCCAP or this statistically average scale data.

Slide 29: Precipitation Changes

OK, jumping to precipitation changes. The same kind of presentations now for precipitations, I'm going to run through these very quickly.

Slide 30: Model Mean Precipitation Changes

For this one I'll take just a bit of time on. This shows the same kind of pattern or distribution of precipitation changes, individual model values organized by periods and red for A2 and blue for B1.

OK, a couple of things here. Number one, there's not a lot of trend over time in this, they're actually in both of B1 and A2, there's a trend towards increasing precipitation over time but if you look at the model spread, you notice that, in fact those who take A2 at the latter part of the point for century is a prime example. The models range from about an 8 percent decrease in precipitation to a 16 percent increase over the region; very, very big ranges in these precipitation values.

Slide 31: Seasonal Precipitation Changes

And that really tells a fundamental story about the models for some of these regions, that in a lot of the area of the U.S. precipitation projections are highly uncertain, there might be, you know, mean model trend but there're a lot of variations among the models, and it's true for seasonal values also which is shown in this particular graphic.

Slide 32: CMIP3, Multi-Model Mean Simulation, Precipitation Difference (%) from 1971-1999

And then if we look at the maps, we see here now, even with that being said, there is some signal in the northeast as you get out in the latter part of the 21st century, that more of the models are showing statistically significant increases than decreases, and we can actually apply this hatching in the southeast and say, well, the models do lean in that direction, so you have some confidence in the northeast towards increasing precipitation.

Slide 33: NARCCAP, SRES A2, Precipitation Change

OK, let's look at some other derived metrics, that's two for precipitation. This is seasonal, I'm going to show this, in the NARCCAP simulations, when you look at seasonal variations, what you see is that the models on an average produce weather conditions in three of the seasons, but very critically in the summer time the models mostly are projecting dryer conditions in the southwest.

Slide 34: NARCCAP, SRES A2, Annual Number of Days Precipitation > 1 Inch

OK, what about extremes of precipitations, we've done these for a number of different thresholds, I'm showing up here the number of days that precipitation exceeds one inch and throughout most of the region, well, actually all of the region, the models are showing an increase in this metric for the northeast.

Slide 35: NARCCAP, SRES A2, Maximum Consecutive Number of Days Precip < 3MM

OK, here's another metrics, on the flip side of the precipitation and what this is showing is the number of consecutive days that there's less than a 10th of an inch of precipitation, so we're taking now about dry spells and whether those dry spells will change in length, and there is a tendency in the models in the northeast that show even though there's a tendency towards increased precipitation, an increased number of heavy raining days, they also are tending to show an increase in the number of dry spells or the length of the dry spell.

Slide 36: Derived Precipitation Variables

And this shows similar kinds of statistics for these derived variables, I won't go through that.

Slide 37: Acknowledgements

Had a lot of help in this who weren't authors, people from the NARCCAP experiment, a bunch of people who helped me with the CMIP3 data and a lot of help on mapping.

Southwest Regional Climatology and Outlook

Slide 1: Introduction Slide

So that's the story for the northeast, I'm going to get to my southeast for you here, get the presentation up. This will go quite a bit faster because I don't have any of the introductory slides and I'm going to skip through some of the graphs that show a similar picture to what we saw in the northeast.

Slide 2: Annual Temperature Pattern

So just to give you an overview, annual temperature in the southwest now, these have areas that they have some of the hottest areas in the U.S. in the lower Colorado River Valley, where the mean annual temperature is above 75, but also have some of the colder areas in the higher mountain regions, a very highly varied region in the U.S.

Slide 3: Annual Precipitation Pattern

Precipitation is also highly varied, generally arid, the semi-arid climate over most of the region with precipitation in most areas less than 20 inches with some notable exceptions, the higher mountain areas of the northern California coast and the Sierra Nevada range where a number of the areas get more than 50 inches.

Slide 4: Important Climate Factors

OK, oops, didn't change that, that's not – they don't get affected by east coast winter storms. Some of the big features out there just as I remember; floods and drought, big problems, drought probably being the most important just because it is an arid region, they're also affected by heat waves and cold waves as well, and winter storms are a real problem in some areas.

Slide 5: Precipitation Trends

What are the trends like in this area? Precipitation, no trend in the annual precipitation, that's also true in the other four seasons, there's slight upward trend in the fall but it's not statistically significant, so this area historically during the 20th century has been dominated by interannual variability.

Slide 6: Temperature Trends

What about temperature? Well, in the southwest there's a very strong temperature signal, a very strong warming that's occurred over the 20th century into the early 21st century, that's true in all four seasons, very, very strong trend.

Slide 7: Freeze-Free Season

If we look at now some of these other metrics, the freeze-free season trend here, very strongly upward, much more so than in the northeast, there's been a lengthening of the freeze-free season in the southwest by about three weeks over the 20th century, that's a big, big change.

Slide 8: Heat Wave (5-yr recurrence)

Heat waves we've seen recently unlike the northeast, we've seen a high frequency of heat waves and dominated by specific years which often happen, but this is a highly statistically significant trend.

Slide 9: Temperature Changes

I'm going to jump right in to future changes. You're going to see that a lot of these are very similar.

Slide 10: Summary of Model Simulations

Slide 11: Seasonal Temperature Changes

Here is the same picture of the standard plot for temperature, it shows exactly the same message as what we did for the northeast, had these variations that by the end of the 21st century kind of equally balanced between the differences in emission scenarios and models, but again the messages about unequivocal warming is very clear and that's the same with the season of variations too.

Slide 12: CMIP3, Multi-Model Mean Simulation, Temperature Difference from 1971-1999

You look at the pattern of temperature change, everything's statistically significant throughout the region, the one signal that shows up here is again kind of related to the coastal moderation or moderation by the ocean, it's a little less warming as you go towards the Pacific Coast.

Slide 13: NARCCAP, SRES A2, Temperature Change

What about season of variations? In the NARCCAP models, the largest warming is occurring in the summer, significant warming throughout the season but there is a tendency for more warming in the summertime.

Slide 14: NARCCAP, SRES A2, Annual Number of Days Tmax > 95°F

A number of days above 95, it just points out, you know, that increase is everywhere, the magnitude depends quite a bit on elevation, for areas where there's a lot of days now at a higher absolute number, the difference is higher, some areas in the south are getting 30 more days above 95.

Slide 15: NARCCAP, SRES A2, Annual Number of Days Tmin < 10°F

A number of days below 10, there's actually very little change in the southern parts of the region because they don't get any now, so you can't have less than none or close to none. Along higher elevation areas particularly in the Colorado Mountains, the models project a 20 fewer days or more in the future.

Slide 16: NARCCAP, SRES A2, Length of Freeze-Free Season

Freeze-free season, here now, it's kind of interesting, we're seeing the largest changes in the western part of the region in California and I think that's probably due mainly to right now the – when it goes deep or low-freezing out there, it doesn't go deep a lot below freezing, you know, in here it's rarely cold days. And so a little bit of warming here – warming were projected to raise those phases above freezing, and so we're seeing lengthening of the freeze-free season out there by about a month or more.

Slide 17: NARCCAP, SRES A2, Annual Total Cooling Degree Days

Cooling degree days, biggest changes are where it's really hot now and – in the southern – southwestern desert regions where they're projecting 800 more days, that's about 20 percent increase.

Slide 18: Slide 17: NARCCAP, SRES A2, Annual Total Heating Degree Days

Heating degree days, the biggest changes again are in the colder regions now, in the higher elevation areas, very much elevation dependent on these temperature-related variables.

Slide 19: Derived Temperature Variables

I'll skip across that now that you're getting a flavor for what's in these reports.

Slide 20: Precipitation Changes

Slide 21: Model Mean Precipitation Changes

Precipitation changes, just to point out here the same picture as we had before, that the range of projected changes is very large compared to the model mean, high uncertainty related to the projected precipitation changes, it’s true for seasons as well.

Slide 22: Seasonal Precipitation Changes

Slide 23: CMIP3, Multi-model Mean Simulation, Precipitation Difference (%) from 1971-1999

Now, very interesting here. I'll spend just a minute on this graph, this shows the six-paneled precipitation changes, and what's critical here is that the models are projecting certainly by the end of the 21st century actually are very robust pattern and it's a pattern – and if you look at it

from a global sense, subtropical dry and middle latitude moistening, that is the subtropics are projected to get drier, the mid-latitude is projected to get wetter. We saw that mid-latitude signal on the northeast where the region was projected to get wetter.

Here in the southwest, we're seeing the subtropical drying were far enough south, that we're in the subtropical belt and the areas – in fact, you know, and then if you look at the map, it indicates that we have a lot of confidence in this projection by the end of the 21st century that the driest region, the driest regions of U.S. are projected to get even drier.

Slide 24: NARCCAP, SRES A2, Precipitation Change

And when will this drying take place? We find in the models that a lot of this is in the spring time and it turns out – if you look at the models, what it is, it's sort of an earlier retreat of the jet stream storm tracks to the north. So in the winter time, it retreats earlier in the spring and then that leaves spring high and dry and that's the time that's very important for the snow areas out there to get their spring snow runoff.

Slide 25: NARCCAP, SRES A2, Annual Number of Days Precipitation > 1 Inch

Number of days, above 1 inch. We see changes towards that left side in the northern parts of the area even despite some of these areas are projected to get drier overall, the number of heavy rain days was projected to get higher.

Slide 26: NARCCAP, SRES A2, Annual Maximum Consecutive Number of Days Precipitation < 3 MM

The number of dry spells or the length of dry spells is projected to get longer throughout the region and by quite a bit in the really dry areas, where the dry spells could be up to three weeks longer in the future.

Slide 27: Derived Precipitation Variables

And these are just some statistics, I won't go over those.

Slide 28: Acknowledgements

So, that's my presentation.

Joel Scheraga: Awesome, awesome, awesome, Ken. Thank you so much, just a beautiful presentation and thank you for doing it in such a timely fashion. I have to say, Ken, there are a number of us sitting in the room – I'm in here alone and we're sitting here marveling at how you made a lot of complex information and a lot of complex concepts readily accessible to us.

And I'm sure people will have questions, for example, about the availability of the data behind the results that you presented. But I must say the results you've already presented in a graphical

and a visual form, I can see will already be extremely helpful to us both at EPA and DOI as we worked with states and local communities on our missions, so I can't thank you enough, Ken.

And I've noted already that quite a few questions have come in for you but, again, I would encourage people not to be bashful and to send in any questions you have for Ken or anybody else, again, just identify who the question is for.

Overview and Use of Global Sea Level Rise Scenarios

Slide 1: Introduction Slide

With no further ado then, let me – let me turn the floor over to Adam Paris and following Adam, we'll have the Q&A session. Adam, over the past 10 years, has worked extensively in both science and policy, and he's one of the people who've worked very hard to bridge the boundary between the two which is what we're trying to do today.

Adam is the lead program manager for NOAA's Regional Integrated Sciences and Assessments program, better known as the RISA program at NOAA's Climate Program Office. And in his – in this capacity, Adam develops and manages various initiatives to strengthen a program for innovating climate science and services relevant to decision makers on the ground, decision makers like those of you who have called in today.

Before I turn it over to Adam, I can't resist observing that Adam has roamed the country from what I would call one estuary to another. If you delve into Adam's bio, you'll see that he grew up in the Chesapeake Bay region but then he spent the early part of his career in the San Francisco Bay Area, and now he's back at NOAA in Silver Spring, Maryland so, again, it's safe to say he's roamed the estuaries of this country.

But more importantly, in doing that, he really – Adam has a mass extensive experience and the expertise as both a coastal geomorphologist as well as a coastal manager. And these days, he is, in fact, science policy wonk as he likes to put it and he's really dedicated to helping coastal managers and communities make informed and resilient decisions and in that – in that spirit, really getting people to think about the future.

So, Adam is going to talk to us today about the new NOAA global sea level rise scenarios and how they can be used at a more local level in decision making. So, Adam, it's your show.

Adam Parris: Great. Thanks. Can you see my screen, Joel?

Joel Scheraga: We sure can.

Adam Parris: OK. Great. OK. Well, thanks so much for having me today. I look forward to get into the question-and-answer session and getting some feedback and really understanding how folks can potentially use this information. And I really thank Joel and the folks at ICF for putting this together.

And I want to just call back to the beginning of the Webinar briefly to say that as much effort, time and effort as Ken and I put into these reports, Anne Waple probably put double that amount of effort into not only the scenarios but the assessment overall. I'm amazed that she's still standing after all of this, so I think a huge debt of gratitude – we all owe Anne a huge debt of gratitude for her work on the assessment.

Slide 2: NOAA Forecast for this Talk

So because I'm from NOAA, I like to give a forecast of what I'm going to say. We like to do that. We like to give forecast at NOAA. So I'm going to talk a little bit about – I'm not going to talk so much about the NCA scenarios as scenario planning methods, talk a little bit about the global scenarios themselves and then as Joel alluded to, I'm going to talk about using scenarios, using these specific set of scenarios.

Slide 3: Wading through the Literature

So right now, when coastal managers approached the issue of sea-level rise, they're going to – there are – many are already doing risk and vulnerability assessments, they're thinking about how to incorporate sea level – plan for sea level rise and what it might mean for their management area. And when they do that, they're confronted with a literature, a pretty vast literature on sea level rise and then sort of thinking about how the global picture affects their regional local space, there is a wide range of estimates and yet there is no coordinated interagency effort to identify agreed upon global sea level estimates.

There're the IPCC assessment reports. There are reports in the National Research Council and then there are many, many different individual studies in the pure literature review that have different answers and that's OK. We want those different answers. Basically, scientists are trying to make different assumptions about the earth system and help us understand where the uncertainties lie and where we might better understand the earth system.

But from a coastal manager's perspective, it would be nice to have a synthesis of the literature and understand the full range of uncertainty. So, in response to that, the National Climate Assessment Development and Advisory Committee commissioned, if you will, this panel of experts which I'll show in the next slide to write a synthesis report and identify estimates for global mid-sea level rise that could be of use for folks out in different locations along the U.S. Coast, as well as the authors for various regional and sectoral chapters of the assessment.

Slide 4: Regions of the US National Climate Assessment

So, you know, we have two audiences, one is very large and sort of ongoing, that is decision makers but then we have the sort of immediate audience of the National Climate Assessment authors themselves. And the idea was that if you could identify at least the global scenario that each region would use, where of relevant, where they have coastline, that then they would – they would bring their regional and local expertise, so they are those regional and sectoral chapter teams who would bring their expertise and adjust the global scenarios accordingly, but that starting with the same set of global scenarios would make for more comparable assessments or complementary assessments.

Slide 5: An Interagency Effort

So, you know, going back to this point about the interagency process, you know, we really – first of all, this is by no means my effort alone. There's – there were a whole panel of experts who really gave so much time and they're from several different academic institutions but also several different agencies. So this really was an interagency effort and we looked at it as an opportunity to sort of prototype what it would be like if agencies came together to provide a sort of a definitive statement on this particular issue.

Slide 6: Scenarios

So, I won't go over this too much because Anne already alluded to this, but just some reminders, scenarios and, in particular, this – the scenario in this particular report are trajectories of environmental change and the primary purpose of these scenarios is to support risk and vulnerability assessment. So they can be useful for coastal management in decision making via those – their role in forming some picture of what risks and impacts and vulnerabilities looked like.

They are not predictions of projections of what will happen and they're not formed under the assumption of reducing uncertainties. So the – so the notion, you know, that – we have seen the knowledge or what we understand about sea level rise in the earth system changed over time, and that uncertainty was likely going to continue to be uncertain at least over the near-term about what that's going to look like. So we're not using projections – predictions or projections.

There are – there are more quantitative methods for producing projections. The IPCC does that. There are – I believe there would be some dedicated synthesis – there is some dedicated synthesis of that in the draft assessment itself. This is not a part of the assessment. It's important to make that distinction. But we didn't hone in on that particular method because we really wanted to acknowledge the full range of uncertainty in the scientific literature.

Slide 7: Why Use Multiple Scenarios?

The other important component of that is that we're – this report is not just about the science on global sea level rise but also that particular body of science in the context of another body of literature on how people make decisions in the face of uncertain future change. So we have this methodology of forecast planning where, you know, if the suite of conditions or environmental variables is known to a relatively confined degree, you can sort of identify a number or a condition to plan to within a general range, so that's this graphic here on forecast planning on the left.

But where you have large uncertainties or – particularly over a large time scale, the scenario planning method or approach is generally followed under the assumption that if you – if you understand what all of those conditions are and how you might respond to all of those different conditions whether it's sunny or rainy or whether there are thunderstorms, then you're more prepared to be resilient in the face in any one of those particular conditions. So planning for multiple scenarios and thinking about how you would respond, what your risks and vulnerabilities are, and what your response actions are for multiple scenarios actually makes you more prepared and resilient in the face of future change.

Slide 8: What Does the Literature Say?
So what does the literature say? There are – what we wanted to do, again, is encapsulate the full range of uncertainty and there are a number of different methods by which you can actually arrive at an estimate for future global sea level rise. The IPCC has relied heavily at least in their fourth assessment report on climate model projections. Those had limited to no considerations or assumptions based on rapid ice sheet loss. Ice sheet loss is the combined contribution of glaciers and ice sheets melting and discharging into the ocean, and that's also chunks of ice falling off of the ice sheets into the ocean and thereby increasing the volume of the oceans as well.

So they were focused primarily on the other main driver or contributors of sea level rise which is thermal expansion, so the –as the oceans absorbed heat from the atmosphere, they expand and then sea level rises, so they were really – the IPCC fourth assessment report was really focused on that thermal expansion or ocean warming.

There are other expert syntheses or assessments from the National Research Council, and then there are these sort of semi-empirical methodologies or projections, and semi-empirical projections attempt to take into account of statistical relationships between observed sea level and observed air temperature. So particularly, as we get further along in our observational record and we see some of the changes that we've seen over the past 10 or 20 years with increasing amount of ice sheet loss, those statistical relationships skew some of these semi-empirical projections a little bit higher than what we've seen in the past.

And then finally, there are other methods where you – like for example, this Pfeffer et al. paper on the far right that just goes through sort of a more theoretical exercise and saying how much the ice sheets in Greenland and West Antarctica could actually contribute, what's the maximum possible contribution.

Slide 9: Global SLR Scenarios

So that's how we arrived to the end points for our scenarios. So the lowest scenario 0.2 meters is actually a linear extrapolation of the observed rate of sea level rise over the past century as measured by tight gauges. We emphasized that using the risk-based framing of the assessment, we emphasized that this scenario would only – should only be considered where there's a high tolerance for risks, in other words, where projects have short life span or flexibility to adapt to it in the near-term, so to take alternative courses of action.

Then the intermediate low 0.5 meters is based on climate model projections. The intermediate high is based on semi-empirical projections and accounts for not only ocean warming but a limited ice sheet loss, and then this highest projection is combined estimates for ocean warming with the maximum possible contribution from ice sheet loss. So this is a scenario that you might consider where – situations where there's very little tolerance for risk, in other words, the life of the project is meant to be on the, you know, 50- to 100-year timeframe, or there's a complex piece of infrastructure where there's not a lot of flexibility to adjust in the near-term, or where there's just an incredibly important asset.

Slide 10: Risk-based Framing

So by using these term "Risk Tolerance" what we're trying to do is to use this risk-based framing which is really – so that's a little bit of jargon. But basically what we're trying to do is say, how do these coastal managers make decisions based on the different time horizons, different planning areas or special footprint, and then different degrees of risk tolerance, in other words how much coastal flooding they're willing to accommodate. So we're trying to situate these scenarios in a context of that risk tolerance.

We made a statement on the full range of uncertainly. So I've just shown that here, we have very high. This is really the main finding of the report. We have very high confidence, greater (9 or 10 chance), the global mean sea level rise will be at least 0.2 meters or 8 inches and no more than 2 meters, 6.6 feet by 2100.

So an, you know, really important thing to recognize in both the previous graphic and this particular statement is that beyond 2100 we don't expect sea level to stop rising. And so, that's really important in terms of thinking the overall amount. But over this sort of time – commonly adapted timeframe of 2100 that's actually in U.S. Global Change Research Act, we have really high confidence that it's between 8 inches and 2 meters.

What I've also shown here on this slide is the rubric, or the definitions if you will, for how we arrived at our confidence levels. And this is based on some of the work that Gary Yohe and Richard Moss and others have done not only through this assessment but also for the IPCC and the New York City Panel on Climate Change.

Slide 11: Greatest Source of Uncertainty

So another thing that we discussed at length in the report is the notion that now the greatest source of uncertainty with respect to these scenarios and whether or not we're at that sort of, you know, lower end or the higher end is how much ice sheet loss will contribute to global mean sea level rise.

And there was one of those National Research Council Reports on the West Coast acknowledging that ice sheet loss is at this point the greatest source of uncertainly, which a bit of a shift. I mean, we have really been focused up until say the past five years or so, we've really been focused on thermal expansion. And as we began to observe more and more some of the declining coverage of ice sheets and greater contributions, that has become a real source of – an important source of uncertainly.

Slide 12: A Decision Analogy

So now, I'm going to shift to using these scenarios. In doing so, I'm going to really focus on how the global or sort of arrive at how the global scenarios would differ from one location to the next. Because we recognize in the report that sea level change will vary in any – in any one region or

location in response to a number of regional and local factors, including vertical land movement and ocean dynamics.

So to do that, I'm going to kind of present a decision analogy. It's very simplified. But the point is if there's a change of rain tomorrow, say 50 percent chance. You are going to take that into account in terms of your lifestyle or what you're doing. But the question isn't, you know, isn't necessarily exactly what the chance is but what do you have – partly, what do you have plan for tomorrow?

So if there's a chance of rain, maybe you leave a little early off for work. Maybe you take a different course because the traffic is going to be bad or maybe you bring an umbrella. But the consequence is of you being 5 to 10 to 15 minutes late to work, maybe aren't that high and then what you have plan for that day. But generally speaking it's probably not the worst.

However, if you have on that same day that there's a slight chance of rain, outdoor wedding planned, you might have to consider renting a tent, moving the location of the event or possibly maybe even canceling the event all together. But the consequences to that are probably tremendously high because you've invest a lot of time, and money and a lot of other people are depending on the outcome of the event.

Slide 13: Why Such a Large Scenario Range?

So similarly just to put this in the context of again, risk tolerance in this scenario, in – towards the lower end of the spectrum you would consider those to be some of the low – intermediate low and lowest scenarios. There would be situations where you have a higher risk tolerance or greater flexibility to accommodate flooding, lower consequences or – and/or ability to change in the near-term. So I've shown an open space here where there maybe some flexibility to shift those assets or take some of the active actions.

Conversely where you have say a large international airport right at the coast, you maybe have a lower risk tolerance because you have less flexibility, higher consequences if that area does get flooded. And really not much ability once you've changed that piece of infrastructure to take an alternative course of action.

Slide 14: Sea Level Change Will Vary Regionally and Locally

So again, we know that that's going to change regionally and locally. So the idea is taking all of that contextual information into account, to tailor these global scenarios to the regional and local level. And there're a number of resources to do that. This is a product from NOAA CO-OPS, showing just how those sea level trends vary across the U.S. coast line. You can see in the Gulf of Mexico and the Chesapeake Bay they are higher – the sea level is rising higher than the global trend as a result of subsidence or sinking of the land surface and in some cases ocean dynamics. Whereas in the Pacific Northwest and parts of Alaska, not all of Alaska but parts of Alaska, sea level is not rising faster, not at all because the land surface is rising.

This just shows you that same sort of picture from a few of the gauges, extreme and sort of average conditions. And this just shows you that for a majority of those tight gauges with records of 60 years or more, that actually – the rate is actually fairly consistent with the global trend. So the global trend is actually pretty important in areas where there is not much vertical land movement.

Slide 15: Coastal Flooding and Extremes

So one of the big drivers in addition to the, you know, vertical land movement and ocean dynamics, one of the big drivers is something that, you know, what's at the forefront of most coastal managers in community's mind is what is coastal flooding? What happens during extreme events?

And, you know, what we emphasize in the report is that we know that any amount of sea level rise will increase the frequency, magnitude, and duration of flooding associated with the given storm.

So there, you know, there is not widespread consensus on the changes in extremes. But you should still take into account what water levels are, you know, during extreme events. So thinking about how sea level rise would exacerbate existing conditions during extremes.

Slide 16: Resources

So in terms of resources to then be able to do that, there are, you know, federal agencies have different reports and different guidance, methodologies. So the U.S. Army Corps of Engineers produced a circular and based the methodology for computing sea level rise at any one time step based on projected curves. They use curve from the 1987 National Research Council Report however. And they built a calculator that is on the Web where you can select the type gauge anywhere in the U.S. and it will calculate factoring in subsidence or uplift, and the amount of sea level rise for five-year time period going out to 2100.

Slide 17: Available via NOAA Digital Coast Tools

And then the NOAA Coastal Services Center has produced a set of companion report that largely details the methodology for actually creating local sea level scenarios. Some of those products are built into the NOAA Digital Coast which is an interagency effort including the Sea Level Rise Viewer.

And we're actually beginning to tailor some of that information to incorporate these global sea level scenarios into some of those products, in collaboration with other agencies including FEMA to help folks in the Northeast and in other parts of the world gradually over time be able to use these global scenarios and integrate them into more regional and local information.

So right now, we know that folks have these advisory "Based Flood Elevations" that FEMA is releasing for New York and New Jersey. Some of them are live now in New Jersey. And what – these are advisory elevations that really attempt to characterize current risk, recognizing that

some of the Flood Insurance Rate Maps that exist for the National Flood Insurance Program are out dated, sometimes 10 or 20 years. And FEMA is working to update those. But in the mean time in the Northeast, people are going to be rebuilding and recovering and making decisions.

So this characterizes current risk. And what the Corps of Engineers, NOAA, the USGS and USGCRP and the White House Council on Environmental Quality are trying to do is create a companion set of information products that help – that draw on these global scenarios, but also local scenarios like the one produced for New York City Panel on Climate Change. And put that in a map services product like what NOAA Digital Coast has in its Sea Level Rise Viewer. And what the U.S. Army Corps of Engineers has in the calculators.

So those should be coming online in a week or two. And you'll be able to use the Corps of Engineers Calculator. There will be a version of the calculator that draws on these global scenarios. And then integrates local tidal observations and estimates for subsidence or uplift in the Northeast.

And then there will be a map services product that NOAA Coastal Services Center is producing that looks almost exactly like this FEMA product. This is for New York and New Jersey and the Northeast. Almost exactly like this FEMA product and then shows beyond the ABFEs or the Advisory Base Flood Elevations, how much – how much in addition would you expect at 2050 and 2100 for the different sea level rise scenarios? For the area around Manhattan, specifically that will incorporate the New York City Panel on Climate Change projections.

Slide 18: Contact Information

And with that, I will stop talking and hopefully answer some questions.

Questions and Answers

Joel Scheraga: Adam, thank you. I think it's fair to say that you truly are the expert at bridging science and policy. You've really provided us with the type of information and tools that really are – or will already empower us to integrate the potential impacts of climate change and sea level rise in particular into our programs. And I must say I love the way you link the sea level rise scenarios to risk tolerance and how decisions are actually made and the types of decisions that are being made. So thank you for that.

We received over the last hour and half quite a few excellent questions. I'm going to turn the floor over to Wendy to moderate the Q&A session. And I'll – as I do that, I'll just ask that our presenters give concise answers since we've gotten quite few a questions over the last hour and a half.

So Wendy, let me just turn it immediately over to you.

Wendy Jaglom: Great. Thanks Joel. And thanks to all the speakers. As Joel said, we have had a lot of great questions and we'll do our best to get through as many of them as we can. For those questions that we aren't able to get to, we'll circulate the questions to the speakers and post written responses to EPA Climate Change Website.

And so, as Joel said, we encourage you to keep answers short while still being informative since we're hoping to get through as many of these questions as we can.

So with that, the first question is for Ken and Anne. And the question is: the reports documenting the regional climate scenarios are very technical. And it's very difficult to discern from the documentation for any one particular region what your projections are for future climate change. Could you tell us, in plain English, what we should be planning for? As we do our work, how can we easily identify the range of scenarios we should use in our work?

Anne Waple: Did you want to answer that Ken? I can, you know, make a – just an initial answer I think.

Ken Kunkel: Oh, give an initial answer and I'll add to whatever you say.

Anne Waple: Yes. I mean, I think the first thing to note is that in the use of scenarios, obviously what we're trying to do is to provide a range and not to give you, you know, too narrow of a future to plan against. So these are sort of illustrative scenarios in some sense, you know, it's not the highest, it's not the lowest, and we can't give you that full range because of course the future is 100 percent uncertain.

But in terms of giving you sort of a brief set or a more usable set of information around the scenarios that we have chosen – I mean, I think we might be looking for your ideas in terms of how to make that usable.

So you have the whole set of maps and graphics for the – two scenarios and for the B1 scenario, would you require sort of numbers of the region? Or, you know, if you could actually give us – maybe send us an e-mail with some ideas about how to provide that in a way that you can take and import that into your decision processes, that would be very useful. But I think that was just a very general answer. Ken, you might have some ideas.

Ken Kunkel: Yes. Well, I don't know that I have any other ideas other than putting together these reports. But they're already very lengthy and we've made choices. The kind of information to present, you know, we've kind of made what we thought was a reasonable choice, you know, there's obviously data underlying all of these. And it's maybe possible to expand the information based on your feedback.

Wendy Jaglom: Great. Thanks to both of you. So the next question is for Ken. How can we access the actual scenario data? How much ever will it take? Is it readily useable? That is – is it user friendly? If not, what steps do we have to take to actually use the data?

Ken Kunkel: Well, at the moment as Anne showed and Anne may want to add to this too. We're able to get the figures separately. Well, that's, you know, we kind of – we're able to do that fairly quickly. We also are planning as Anne pointed out too, to add, you know, data to this sites. Again, with probably feedback from you and other users about what are the highest priorities. You know, we're thinking immediately that that's maybe the – one of the things we can probably do more quickly is to make map layers available for the – all the maps that we have in these reports. And that hopefully would help those who would like to overlay the information on their own analysis.

That's sort of I guess my first reaction, I think that beyond what other level of detail in terms of data availability is provided would depend a lot on feedback, you know. We have our own ideas but we don't know if those would be the most optimum types of information to provide.

Anne Waple: In essence what we're trying to do I think is to – at some point make all of this fully reproducible. And we know that that takes the underlying data, the access to the models individually as well as in an ensemble, the description of what was done to them, the algorithms that were actually used, and then the derivative information behind the maps. That's not all easy to do in terms of short amount of time.

So where would be the most useful information for you to plug in is going to be really helpful for us to just prioritize how we step through that progress. And that will actually also help us for the National Climate Assessment in general, because this was a very useful exercise for us in getting all of the information for the whole National Climate Assessment to become a little bit more transparent and traceable. And I think, you know, if we can get this right and understand the first level of priority, in terms of making data useable and accessible, then it will help us in all kinds of other things too.

Wendy Jaglom: Great. Thank you. So the next question is for Adam. And the question is the NOAA sea level rise scenarios and global scenarios. How useful are they for work we are doing

at the local level? Can we simply use these global projections or must we make adjustments to them for our local condition?

Adam Parris: Yes. Well, I thank you for that question. You know as I said, we absolutely anticipate that folks would have to take these and then adjust them for the local level based on all of those factors like vertical land movement and what the outlook or picture is for the changing frequency and magnitude of extremes and ocean dynamics.

But, you know, I think where one of the strengths of the scenario playing approach comes in is, you know, you're not – it would be very easy to compound uncertainty by trying to having to combine or integrate all of that different information from the global scale down to the local scale. And by taking such a wide range of the literature in at least for the global mean sea level rise component of your scenario and by emphasizing the use of multiple scenarios, in other words, not just one of the scenarios that you then go and perfect but actually just trying to look across multiple scenarios. Then you really take into account your sensitivity across a range of condition and hopefully, making a more robust decision.

So, you know, it's absolutely important to add in regional and local information, I would say it's equally important to consider a range of scenarios as it is to, you know, to think that you would perfect any one of these scenarios.

Wendy Jaglom: Great. Thanks, Adam. The next question is for Joel, and the question is, you say the scenarios can be used by all federal agencies. But then one of the bullets on one of your slide said EPA and DOI. I'm looking for confirmation that other agencies can use these, for example, DOD.

Joel Scheraga: Thanks for that question, Wendy. It's a great question. Let me first, before I answer the question, just make one acknowledgment that I failed to make in my introductory comments. I alluded to this being a partnership, this Webcast between EPA and the USGRP. There's one person in particular at the U.S. Global Change Research Program who's done a phenomenal job helping to make this happen. And that's Emily Seyller, who I believe may be on the call right now. So I just want to publicly thank Emily for just weeks and weeks of hard work.

To answer the question, unequivocally, yes. In the slides and introductory comments I made, I focused on EPA and DOI simply because the participants in this pilot Webcast are from EPA and DOI. And as I mentioned, depending upon your feedback that we'll get at the end of this Webcast, the USGCRP may host similar Webcast for other federal agencies.

But having said that, unequivocally, the regional climate scenarios and sea level scenarios that we've talked about today are already available to all federal departments and agencies including our colleagues at DOD. And this is really important also not just for their own work but because it also enhances our ability as a federal family to work together and to coordinate our efforts across federal agencies as we work together in particular places. So thanks, Wendy.

Wendy Jaglom: Thank you. And the next question is for Ann. What would participatory scenario planning look like? Who might be involved and what skill?

Anne Waple: That's a great question. So I think we are, first of all, open to suggestions. Secondly, we actually have a small internal meeting on Thursday here at the GCRP office where we're beginning to get into what comes next for the scenario process, and that is both looking at what we would do to enhance the current set of scenarios, where we want to take the efforts in broad terms, how it's – how we need to update things.

But it would also involved where is our investment and how would we go about starting a process to involve multiple layers of decision makers at multiple scales in the participatory process. So in answer to the question, we don't have a specific answer just yet but we are very much interested in working on that and seeing where – what it would take, you know, to really invest in that.

And so if you have some particular suggestions do let us know. But I think you'll see a little bit more on that in the near future. We're obviously hoping that there aren't, from the federal side anyway, too many restrictions in terms of, you know, whether we can start that from a budget perspective. But certainly, we have lots of partners who I think would be really interested in participating in that, helping us get something up and running and even in the pilot ways that we can begin to build on.

I feel like it's not – that's not a very good answer but I do want to say that it sort of coming soon and it's something we want to start working on in more detail.

Wendy Jaglom: Great. But I'll ask – I'll ask you another question. So the next one for is, is there a talking points document about explaining to the public or other stakeholders the difference between a scenario and a forecast. This would be helpful for land management agencies using this data.

Anne Waple: Also a very good suggestion. So that – if you go to the Web site, there are actually frequently asked questions on there that do – I think we have a couple of questions that get to what these scenarios are. And certainly, you're welcome to use these slides where we have explanation about that.

If that is something that would be broadly useful, then I think we can put together, you know, a one-page fact sheet or something that explains the scenario process a little bit more helpfully for people who are not familiar with it. So if that's something that several people want to or you think it would be useful to distribute, let us know. We can – I think that wouldn't be too difficult to put together.

Wendy Jaglom: Great. Thank you. I'll move on to a couple of questions for Ken. So this one is – the development of the kinds of the data shown in this scenario relies upon a lot more than the emission scenarios. Global models and either regional models were downscaled. These are hugely consequential choices about which there is much confusion. Can you touch upon how you navigated these choices – the scenarios you have clearly made choices at each level.

Ken Kunkel: Yes. Well, first of all, I probably should just state that I did have an advisory panel of really tough climate modelers that helped me early in the process. And that was – that was invaluable. Beyond that, you know, it was – there is a lot out there, a lot of choices to be made. We tried to stick with some, I would say, out in the middle of road choices and NARCCAP is good example.

There's actually quite a few of regional climate model stimulations out there. But this was an organized project, all using the same – some basic or similar kinds of experimental conditions to run these scenarios or to run the – to perform the simulation. And the – you know, these are all top end modeling groups. The similarity of the runs meant that we could combine them without any issues about, you know, combining apples and oranges. And the periods of simulations were long enough that we could – we could use them in a similar way to the way we are using the global model data.

So I think we just took some common sense approaches to this and along with the advises from the top-end modeling experts to guide us in those choices.

Wendy Jaglom: Great. Thank you. So another question for you Ken, similar to the question earlier about data availability, and this one is a little more specific. Will the data be – attributes for the shape files be placed on the Web site for downloads specifically for temperature precipitation, present humidity, and MM5 and bio format.

Ken Kunkel: And what was the last thing you said, MM5 format?

Wendy Jaglom: Yes. Present humidity and MM5 format. I'm just the messenger.

Ken Kunkel: I'm not sure what that MM5 meant but in general, yes, I think our goal barring some alternative feedback would be that all of the maps that we have in the report, we would be moving towards getting the shape files, the map layers that went in to producing those maps out there. So that would include the actual, you know, data, I think the raster files files that are used along with the map overlays and so on.

So the plan would be to – that would probably be – probably the first thing we work on, and those would be available off the Web site, directly off the Web site.

Anne, do you have anything to add to that or counteract that?

Anne Waple: No. I think the only thing I would say is that is that when we look at the formats that we'll put information online, we would probably want to stick with the most widely used format. And then encourage people to customize beyond that and maybe we can create some more collaborative kind of spaces where if you can create the formats that are most usable for you, maybe you can also upload them to the site or something.

So I think, you know, from a central perspective, we just want to make sure that we understand what's broadly useful. We'll focus mostly on that because we'll also have to focus on updating

the scenarios and putting new information up there. But I think we're open to whatever is most broadly useful, yes.

Wendy Jaglom: Great. Thanks to both of you. So moving on to a couple of questions for Adam. The first question – isn't the low scenario less than the current rate of sea level rise? The rate of SLR would have to decrease to hit that change.

Adam Parris: So the – you know, over the past, since 1992, we have had observations using satellites that have shown a higher rate of sea level rise, specifically sea levels according to the satellite have been rising and some type gauges have been rising 3.2 millimeters per year as opposed to the 1.7 millimeter per year rate that has been observed globally through a compilation of type gauges over the past 100 years.

So that would lead you to believe that the – to achieve that point to meter rate, it would have to go back to 1.7 millimeters per year or that, you know, sea level rise would have – the rate of sea level rise would have to decline for a period time between now and 2100. A couple of things of note though, you know, it's hard to see in the graphic that shows the observed record and the scenarios. But the global trend has varied considerably about the – there's considerable variability about the main trend.

So, you know, even though it has risen 8 inches over the past century sea level, there were periods of time where the rate was greater or including, you know, 15 to 20 year periods of time where the rate was greater than or less than 1.7 millimeters per year. And for that reason and because, you know, it takes a long time, some of the variability in global mean sea level rise is affected by variability in climate patterns, variability in oceanographic patterns from one ocean base into the next, ocean circulation patterns.

A 19-year period, the oceanographic community generally feels or at least once week consultant, including the chief scientist for NOAA's National Ocean Service Steve Gill. You know, they generally feel that 19 years or 20 years of data is not sufficient to – especially compared to 100-year data set to capture all that variability that the tide gauge record captures.

All of that said, it is the lowest end scenario. And we do say in the report that it is both the lowest scenario and the intermediate low scenario are optimistic scenarios of future change, where they would only be considered where you have again, lower tolerance for risk. You're only thinking about shorter timeframes, decisions that you would implement quickly and that would only last for shorter periods of time and/or where you have great flexibility to change your course of action.

So for example, you know, if somebody is doing a beach nourishment project that's only meant to last like five years, then, you know, you might not consider necessarily the highest end but you still want to consider multiple scenarios. And it's also important to emphasize it think that, you know, similar to some of the climate trends that Ken showed, you really start to see the scenarios diverge around mid century. And so that's where the uncertainty really starts to increase.

However, you know, we do anticipate or we're not ruling out the possibility for surprises. So I think that answers the question.

Wendy Jaglom: Great. Thank you. And with that, I'm afraid, we ran out of time. So I want to once thank all of the presenters for the excellent presentations and responses to the questions. I also like to thank all of the participants on today's call particularly those of you that asked questions. We had a wealth of really great questions but unfortunately, we weren't able to get to all of them but we will post the answers to the unanswered questions to EPA's Climate Change Web site as soon as we can, along with other materials from the Webcast.

So once again, thanks to everyone who participated on the call. Thank you our presenters and I think that's it for today.

Operator: This concludes today's conference call, you may now disconnect.

END