Environmental Science Distinguished Speaker Series
AMERICAN UNIVERSITY
The Honorable Dr. Jane Lubchenco
Under Secretary of Commerce for Ocean and Atmosphere and Administrator
November 19, 2009
As Delivered

INTRODUCTION:

[Slide 1: INTRO]

As one of the scientists on President Obama's team, and as head of the National Oceanic and Atmospheric Administration within the Department of Commerce, it is a special privilege for me to participate in this series of lectures, especially at such a critical time for attention and action on climate change.

Let me begin by thanking the host of this event, Dr. Kiho Kim, Chair of the Department of Environmental Science, and Dr. Peter Starr, Dean of the College of Arts and Sciences, and the entire University community for welcoming me to you campus tonight. My title tonight is NOAA Climate Science and Services.

As the world enters 'no analogue state' – a world so altered by climate change that it is outside the bounds of past climate cycles – it is time to act to reduce emissions of heat-trapping pollutants

and to adapt to changes that are unavoidable. In other words, to avoid the unmanageable and mange the unavoidable and as demand for information about climate change grows explosively, it is time to deliver more timely and useful information to people around the world. Both depend on good science.

[Slide 2: President Obama]

In the short time that President Obama has been in office, he has made it clear that he considers addressing climate change to be a high priority and that our choices will be informed by scientific knowledge. As he said to the National Academy of Sciences, "Science is more essential for our prosperity, our security, our health, our environment, and our quality of life than it has ever been before."

Since he took office, President Obama has dramatically shifted US policy on climate change. He has emphasized that good government depends on good science, and that the scientific evidence of climate change is compelling. The President has done more to reduce emissions than ever before. He made sure that $80 Billion of the American Recovery and Reinvestment Act – the stimulus package – is an investment for clean energy, including the largest ever investment in

renewable energy, which will double our generating capacity in 3 years. In May, the President announced historic joint fuel/CO2 tail pipe standards for all new cars and trucks. And we've forged more stringent efficiency standards for appliances like refrigerators and microwaves, and have dozens more appliance standards under development.

President Obama strongly supports passing comprehensive clean energy and climate legislation as soon as possible. The United States House of Representatives has passed a comprehensive energy and climate bill that would promote clean energy investments and lower U.S. greenhouse gas emissions more than 80 percent by 2050.

In my remarks today, I wish to focus on the importance of advancing both climate science and climate services, the need to invest in both mitigation and adaptation efforts.

As an ecologist, I look at the earth system holistically. I appreciate the importance of connecting the physical, biological, ecological and human parts of the earth system. And I believe that the scientific understanding of these interconnections must underpin the development and implementation of solutions.

[SLIDE 3: OUTLINE]

So today, I would like to spend my time talking about the following four areas:

1) Climate Services…the importance of connecting the science with the users of information; and establishing a new paradigm for 'climate services'.
2) The findings of a recent report, the Global Climate Change Impacts in the United States, and its global relevance.
3) The untold story of oceans and ocean ecosystems in the climate dialogue, highlighting the economic opportunities and societal benefits of healthy oceans and coasts.
4) And finally, the importance of advancing climate science to provide ongoing support for climate services. I'll emphasize NOAA's contributions where relevant.

So let me start with Climate Services.

CLIMATE SERVICES

[SLIDE 4: WCC-3]

In September, I had the honor of leading the US delegation to the World Climate Conference – 3 in Geneva, the third in the series of World Climate Conferences.

It was an important conference with a strong outcome that will be essential to ensuring that the outcomes of COP-15 can be successfully implemented.

A few words about the history of the World Climate Conferences will put this meeting in context. The 3 World Climate Conferences have been both prescient and bold, tackling critically important climate issues before they were broadly appreciated.

Decisions taken at the first and second World Climate Conferences set in motion what is now recognized as an impressive legacy – this includes the core scientific capacity that enabled our understanding of the climate system, and contributed to the establishment of the Nobel-prize winning IPCC, and a global climate observing system that serves as the backbone for national and international climate assessments and provides a baseline for research and modeling efforts. This is a powerful legacy.

The second World Climate Conference also laid the foundation for the United Nations Framework Convention on Climate Change -- the international treaty that guides our collective commitments to reduce

global greenhouse gas emissions and that, in recent years, has taken a leadership role in efforts to adapt to climate changes that cannot be avoided.

As we know, the Framework Convention is bringing the attention of the world here, to Copenhagen, in just a few short weeks, and expectations are high.

The need for aggressive action on climate change is abundantly clear from the impacts of warming that we have already seen and the projection of a radically altered world. These changes have profound implications for society. They underscore the urgent need for ongoing scientific information to aid decision-makers in developing and evaluating options for addressing climate variability, mitigating climate change and adapting to a climate-changed world.

Today, user demands for climate information are increasing rapidly. Decision-makers at all levels of government, business leaders, civil society and individual citizens are asking how they can best prepare their communities, businesses or lives for the impacts of climate change. In particular, users need climate information and assessments

at scales that are relevant to their concerns. Scientists are increasingly able to provide the "right scale" information.

Lives, prosperity and social stability are at stake.

We are poised to seize the opportunity to use the wealth of science-based information about climate change and variability and translate it into meaningful information that can be used to inform critical decisions at the right scale, across multiple sectors and around the globe.

[Slide 5: Graphic of examples]

Imagine a world in which:

- Farmers are able to determine what to plant and where, based on drought forecasts 3-5 years out.
- Coastal communities are able to plan for sea level rise and storm intensity.
- City planners or water resources managers are able to ensure the availability of water for drinking, energy production, agriculture and many other uses
- Public health officials are ready for, or even able to avoid, outbreaks of malaria based on longer-term forecasts of precipitation.

These outcomes rely on timely 'climate services', services that would offer untold economic, environmental, human health, and national security benefits.

The vision of services like this provided the motivation for the outcome of the World Climate Conference-3. The conference opened with an Expert Segment that engaged a wide cross-section of climate scientists, expert providers of climate information and the users of climate information and services in a wide-ranging discussion on the essential elements of a new Global Framework for Climate Services. The meeting ended with a High Level segment that adopted this concept of a Global Framework. Work is now underway to establish a high level Task Force to further develop the framework. For this Global Framework to reach its potential will require active engagement by scientists, governments and a multitude of users of climate services.

Science-based climate services are becoming increasingly importantly and we expect the demand to grow, especially with the focus on COP-15.

I would like to now shift to specific examples of how science can inform the critical decision that need to be made in light of a changing climate.

GLOBAL CLIMATE CHANGE IMPACTS REPORT

[SLIDE 6: GCCI Cover]

In June the United States released a report that summarizes the impacts of climate change on different regions and sectors of the U.S. titled "Global Climate Change Impacts in the United States," the report is written in plain language with easy of understand graphics.

NOAA, my agency, played a major role in its development. It was produced under the auspices of the interagency U.S. Global Change Research Program (USGCRP), comprising some 13 science-based departments and agencies, including the Departments of Agriculture, Commerce, Defense, Energy, Health and Human Services, Interior, and Transportation, to name a few.

It was authored by a team of top scientists from those government agencies as well as from major universities and research institutions

specializing in climate change and the impacts of climate change, and it underwent an extensive peer review process.

It is the most authoritative scientific assessment of climate-change and its impacts on the United States – impacts already being felt, and impacts yet to come.

It is designed to be accessible to decision makers at all levels – national to local, and it contains new and updated information on climate science, including research findings more recent than the last IPCC report.

It also makes the critically important point that decisions now will determine whether climate change will result in big changes or smaller ones.

[Slide 7: GCCI Regions]

The report describes current and projected impacts broken down by *geographic region* and by economic sector -- including Energy, Water, Health, Agriculture, Transportation.

And by looking at regions, instead of the nation as a whole, we can focus at scales that are important to real people and their interests, security, and comfort.

[Slide 7: GCCI Findings]

A key finding of this report is that climate change is happening NOW. Here are some of the documented changes.

- U.S. average temperature has risen by 1.5 degrees Fahrenheit over the last 50 years.
- We've had more rain coming in heavy downpours that can cause flooding.
- Less winter precipitation is falling as snow and more as rain. So there's less snowpack in the mountains, and it melts earlier in spring. These changes alter the amounts and timing of river flows, making less water available in summer, which has many impacts, such as the use of hydropower.
- Sea level has risen along U.S. coastlines. Some places are seeing much greater rises than others – and similar regional differences are expected in the future.
- Glaciers in our mountain West and in Alaska are melting, and permafrost is thawing.

- *All of these changes have been shown to be linked to the increase in heat-trapping gases caused by burning fossil fuels like coal, oil, and gas.*
- Across the country, the growing season is about two weeks longer, primarily due to spring arriving earlier than it used to. Now, that may sound like a good thing, and in some ways it is.
- There are both positive and negative effects of many of these changes. But, overall, most impacts will be negative. This is true partly because we've designed and built our infrastructure for the climate we've HAD, not necessarily for the climate we're GOING to have. For example, we've designed our water systems for temperature and precipitation patterns of the past century, and those patterns are now changing. We've built our coastal cities along the existing shoreline, not anticipating sea level to rise several feet in this century.

The report further explains that another reason most of the changes will be detrimental is because of the RATE of change. If climate changes slowly, there's a better chance that society and natural systems can adapt. But climate is now changing at an unnaturally rapid rate, and the projections are for EVEN MORE RAPID change, if heat-trapping emissions are not curtailed.

I will guide you through some of the kinds of climate changes and resulting impacts we're seeing in the United States, and what's in store for our future.

[Slide 9: CO2 Graph]

- 800,000 year record of CO2 reveals that it is 30% higher that at any time in the nearly million year record shown here and is therefore not a result of natural cycles.
- This is primarily a result of human burning of fossil fuels

And we know why….As you can see on this graph, the industrial revolution marks a clear change in the atmospheric composition. The fact that other human-influenced gases change at the same time as CO2 also indicates that it's a result of industrialization.

[Slide 10: Temp/CO2 Graphic]

The world has already seen – on average – about 1.5 degrees Fahrenheit of warming during the past 50 years. And we're expecting between 2 and 11.5 degrees of additional warming in this century. These temperature increases are expected to be at the lower end of

this range if heat-trapping pollutants are substantially reduced. They'll end up near the upper end of the range if emissions continue to grow as they have been.

[Slide 11: CO2 Scenarios]

This chart shows observed and projected increases in global average temperature under three different emissions scenarios. None of these take into account any policy changes designed to address climate change.

The lower one is not a best case, meaning an aggressive reductions in emissions now could put us on a path to less warming than shown here.

However, the highest is also NOT a worst case. In fact, recent emissions have been higher than those assumed in the highest scenario shown here. That means staying the current course could raise global temperatures as much as 11.5 degrees. And this could be even higher in the U.S., which is projected to warm more than the globe as a whole.

[Slide 12: Human and Natural Influences]

Based on a range of climate models – cannot simulate observed climate without including human influences. Only way to explain warming of the last 100 years is to include human influences.

A common misconception is that the globe would be warming anyway, even without human influences. Actually, what we see is that natural forcing alone would likely produce a slight cooling.

[Slide 13: Heavy Precip Map in US]

In addition to rising temperatures, we've seen significant changes in precipitation. One of the most important changes we've seen across the nation is that more rain is coming in the form of heavy downpours. There are fewer light rains and more heavy rains in every region. An important message from this map is that the heaviest storms are even heavier than before. You can see that the largest percentage increases in the heaviest downpours have taken place in the Northeast and Midwest. So it's no surprise that we've seen some record flooding there. And we understand why warming causes this. Higher temperatures mean more evaporation, putting more water vapor in the air. Then, when a storm system comes along, all that water dumps out in a heavy downpour.

There are also longer dry periods between these downpours. This is why a warmer world tends to have more of both the dry extremes and wet extremes. This pattern is projected to continue, with higher emissions meaning greater increases in the heaviest downpours.

[Slide 14: Population Map]

This slide demonstrates that not only are we vulnerable to climate change in significant ways, but climate change will also occur against a backdrop of other social and environmental changes.

We are seeing some of the highest population growth in an area that is already dry and where we also expect the climate to continue to dry. This climate change combined with population increases will exacerbate vulnerability in this region – without significant adaptation and mitigation approaches.

Climate exacerbates and interacts with other stresses.

Population is increasing the most in an area with already stressed water supplies, in an area which is predicted to become significantly drier.

The population of Florida (in the Southeast United States) is also increasing – putting more people in the path of severe storms, droughts, hurricanes, sea level rise and other impacts of climate change, all impacts of rising temperatures.

[Slide 15: Map of Hot Temperatures]

This next slide shows an impact of temperature increase, with the number of very hot days. These maps show the number of days per year, over the coming decades, when the temperature will exceed 100 degrees. Higher emissions of heat-trapping pollutants result in more temperature rise and many more days above 100 degrees, as shown in the top map on the right. For example, an area in Texas – the southern, central tier of the United States – that now sees 10 to 20 days per year over 100 degrees, by the end of the century under a higher emissions scenario will experience more than 100 days over 100 degrees.

This kind of extreme heat will have major impacts on the economy, and our health and well-being.

Our health will be directly affected by more very hot days and heat waves. Extreme heat waves, which are currently rare, will become much more common in the future. At the same time, the U.S.

population is aging, and older people are more vulnerable to extreme heat. Increases in heat-related illness and death are projected in cities across the nation, especially under higher emissions scenarios.

There are success stories regarding adaptation to heat waves. For example, Philadelphia, in the Northeast, has implemented a successful system for reducing the risk of death during heat waves that has already saved lives. The city of Chicago, in the Midwest, is working to reduce urban heat by using green roofs and planting trees.

[Slide 16: Map of Spruce Beetle]

Another key finding of our study is that there are thresholds in the climate system that we can expect to cross as climate continues to change.

One example is illustrated in these maps of the Kenai Peninsula in Alaska. During the 1990s, south-central Alaska experienced the largest outbreak of spruce beetles in the world as rising temperatures allowed the beetle to survive the winter thus have 2 full population cycles in one year, not the usual one. Drought-stressed trees were unable to fight off the infestation.

These kinds of thresholds are important to consider when thinking about climate change impacts. Temperatures can rise a certain amount with little effect, but then, if a particular threshold is crossed, the impacts can quickly become dramatic.

Temperature thresholds can be an important part of multiple-stress stories. For example, salmon have been under considerable stress in the Northwest because of dam building, logging, pollution, and overfishing. As a result, their populations are already at historically low levels. The additional stresses will make it more difficult to restore depleted salmon populations.

[Slide 17: Impacts to Crops]

In the context of climate variability and change, agriculture has long been considered one of the most adaptable sectors of our economy. Farmers are problem solvers. Nonetheless, climate change is projected to pose a variety of new challenges to both crop and livestock production.

Important among these climate-related challenges for crop production is the management of insect pests, disease pathogens and weeds.

Rising temperatures allow both insect pests and disease pathogens to expand their ranges northward. Some areas such as the upper Midwest are experiencing rapidly-rising winter temperatures. That means that larger numbers of insects escape being killed by extreme cold and so their populations grow. These climate-related problems with insects and disease pathogens mean that more pesticides or other means of pest control will be needed.

Besides rising temperatures, increasing carbon dioxide levels in the atmosphere will also affect agriculture, in both positive and negative ways. Rising carbon dioxide generally increases plant growth as long as there is also sufficient water and nutrients. However, some of the plants that seem to benefit most from rising carbon dioxide are weeds. This means that more herbicides or other forms of weed control will be needed.

Climate change will also cause other challenges for agriculture. Extreme events such as heavy downpours and droughts are likely to reduce crop

yields. And livestock productivity is likely to be reduced due to increased heat, disease, and weather extremes.

OCEANS, COASTS, AND CLIMATE CHANGE

[Slide 18: Ocean Pictures]

Now I would like to turn your attention a subject near and dear to my heart – that is, oceans. Over 70% of the planet is covered by ocean. The ocean is the major regulating force in the Earth's climate system and represents the largest carbon sink in the planet. Healthy marine and coastal ecosystems and their services are essential to maintain the Earth's life support systems. Climate change and ocean acidification are jeopardizing food security, shoreline protection, the provision of income, livelihoods, and sustainable economic development. I have spent my career focusing on oceans…and I want to emphasize the importance of continuing our work to better understand the oceans and the potential impacts of climate change on them. We urgently need a strong focus on ecosystem-based ocean science to inform decisions about adaptation to climate change. This would involve an interdisciplinary understanding of how coastal and ocean ecosystems work, how they are changing and what policies and practices are most

likely to result in the continued provision of the services we want and need from those ecosystems.

[Slide 19: Ecosystems]

An ecosystem perspective also provides a broad array of possible tools for adaptation to climate change. Climate change interacts with and exacerbates other changes ranging from overfishing to nutrient pollution to invasive species and habitat destruction, Removing any or a number of these stresses is likely to enhance the resilience of the system to other changes. In other words, ending overfishing, or reducing flow of excess nutrients to coastal waters, or stemming the introduction of nonnative species may make it more likely that species will be able to cope with some climate-related changes.

[Slide 20: Dead Zones]

Equally important is the need to acknowledge that surprises are likely in store for us as human actions disrupt many fundamental biogeochemical and ecological processes. The appearance of hypoxia and anoxia on a routine basis during the summertime of the coasts of Oregon and Washington – in the northwestern portion of the United States -- is an example of an unanticipated

change with possibly serious consequences. Each summer since 2002, what was formerly a rich ecosystem has become depleted of oxygen, with unknown consequences for the ecosystem and its fisheries. Changes in ocean and atmospheric circulation, most likely connected to climate change, appear to be the culprit. Expansion of hypoxic and anoxic areas in the other major eastern boundary upwelling ecosystems (off Chile/Peru, Namibia/South Africa, and Morocco) lends support to the hypothesis that these wind-driven ecosystems are undergoing fundamental changes.

Those coastal upwelling ecosystems represent only 1% of the surface area of the oceans but they have historically provided 20% of the fisheries. Knowledge that slight changes in oceanic and atmospheric circulation can trigger radical changes in ecosystem dynamics provides compelling rationale for more precautionary management. But what does managing with the expectation of surprises look like? These are rich areas for research and management alike.

[Slide 21: Ocean Acidification]

One of the unanticipated consequences of climate change is ocean acidification -- what I call climate change's "equally evil

twin," provides yet another major threat to coastal and ocean ecosystems. As oceans take up carbon dioxide from the atmosphere, the chemistry of the oceans is altered, which in turn affect corals, shellfish, and other living things that form their shells and skeletons from calcium carbonate. Getting a better handle on rates of change in ocean chemistry and consequences to marine biota are high priority, and NOAA's Pacific Marine Environmental Laboratory is a pioneer in this work.

[Slide 22: OPTF]

Giving appropriate attention to the oceans, President Obama signaled his intent to provide leadership on oceans and asserting our (QUOTE) "stewardship responsibility to maintain healthy, resilient, and sustainable oceans and coasts…for the benefit of this and future generations," (UNQUOTE) by establishing the Interagency Ocean Policy Task Force. I was asked to co-chair this Task Force along with Nancy Sutley, the Chairwoman for the White House Council on Environmental Quality.

The Task Force, with vigorous participation by NOAA and 17 other departments and agencies, is hard at work to develop

recommendations for a national policy for oceans, coastal and Great Lakes ecosystems, a framework for policy coordination, and an implementation strategy that identifies ways to meet the objectives of the national policy.

In his charge to the Ocean Policy Task Force, President Obama directly addressed the climate change-oceans link. "Oceans both influence and are affected by climate change," he said. "They not only affect climate processes but they are also under stress from the impacts of climate change."

[Slide 23: Oceans and Coasts]

And here again, I would like the reference the *Global Climate Change Impacts Report.* It clearly finds that, oceans are warming, corals are bleaching, and along the coasts, sea level is rising and storm surge is an increasing threat.

Coastal areas also are major centers of economic activity. Six of the nation's top 10 freight gateways will be threatened by sea-level rise. Seven of the 10 largest ports are located on the Gulf Coast. The region is also home to the U.S. oil and gas industry and two-thirds of all U.S. oil imports are transported through this region.

To sum up, this vital energy and transportation infrastructure will be at risk with the expected sea-level rise and associated storm surge.

Over the last decade, I have had multiple opportunities to participate in listening sessions with hundreds of Americans in dozens of communities on coastlines throughout the country. I have heard people from all walks of life passionately describe what they want from their oceans and coasts.

[Slide 24: Americans and Oceans]

Americans want and expect: clean beaches, healthy seafood, stable fisheries, good jobs, abundant wildlife, vibrant coastal communities and clean energy…and I believe this view is shared by many of our international partners.

COMMITMENT TO CONTINUING INVESTMENT IN CLIMATE SCIENCE

]Slide 25: Science graphic]

The final section of my remarks will remind us of the importance of a continued investment in science. Our understanding of the climate system will need to continue to improve. Continued investments to

enhance our research, observations, modeling, decision-support tools and communication capabilities are needed.

And I would like to take a moment and highlight a series of examples of the great work the National Oceanic and Atmospheric Administration, or NOAA's, is doing to advancing climate science.

[Slide 26: NOAA Climate Science and Service]

NOAA has been in the climate business for many, many decades, before climate was in the spotlight. Our infrastructure includes observing systems, monitoring, research, modeling, predictions, projections, assessments, and services.

[Slide 27: Observing Systems]

Data is fundamental to all climate activities (monitoring, research, modeling, assessments, products, verification, and services). And NOAA operations 109 observing systems.

[Slide 28: Observing Systems]

NOAA monitors greenhouse gases and carbon dioxide. In fact, in 2007, NOAA celebrated its 50-year CO2 record at Mauna Loa.

[Slide 29: Sea Level Measurements]

NOAA measures changes in sea level. Our National Oceanic Data Center maintains the world's largest collection of historical and modern ocean profile. These records of temperature and other variables such as salinity, oxygen, and nutrients allows scientists at NODC and other scientific institutions to help determine the role of the ocean as part of earth's climate system and forecast weather.

[Slide 30: Modeling]

NOAA offers a seamless suite of forecast, prediction and projections spanning weather and climate time scales.

[Slide 31: Seasonal Predictions]

NOAA produces operational climate products on a seasonal to interannual timescale, such as El Nino/La Nina predictions, drought outlooks, seasonal temperature and precipitation outlooks, and heating and cooling degree days.

[Slide 32: Earth System Models]

NOAA is using high performance computing to run global earth system models, and working to downscale models to get reliable predictions on a regional scale, where people make decisions.

[Slide 33: Assessments]

NOAA is a major participant in numerous climate assessments both internationally, like the IPCC, and on a national scale. In fact, 73% of the US Government authors and reviewers of the Fourth IPCC assessment reports for Working Group 1 – The Scientific Basis – were from NOAA.

[Slide 33: Communications]

Last, NOAA is really putting effort into the effective communication of scientific information. We have done an extensive study on climate literacy and we are develop a web-based climate portal such that multiple types of audiences can access climate information.

Each of these areas, from NOAA and the rest of the scientific community, collectively, provides a rich arena for making fundamental discoveries that are immediately relevant to policy and management needs. The old 'applied-basic' framing is no longer applicable when so many of our policy and management questions require advances in our fundamental understanding. The cutting edge of science is now squarely on the vary topics requiring policy decisions.

This new knowledge will strengthen the utility of climate services, thus increasing the sustainability and resilience of our communities.

To work, solutions must fit local circumstances and produce results that people can use. Climate services must be relevant, accessible, timely, open, reliable and sustainable.

This is a time of rapid change. The pace and nature of changes in the Earth's climate reinforce the need for delivering targeted climate services at appropriate scales.

I'd like to conclude by noting with the above examples in mind that this is a very exciting time for policy entrepreneurship and experimentation in government. I accepted my position because President Obama made it clear that he was committed to making policy based on good science, and that he is willing to tackle the grand challenges of our times.

Because of the fierce urgency of our problems, now is the time to think creatively, to look for unique connections, and try innovative approaches. As Albert Einstein said, "We can't solve problems by using the same kind of thinking we used when we created them."

[Slide 34: Thank you]

Thank you very much.