Global Climate Change Commission Meeting
Wednesday, January 16, 2008
10:00 a.m.
Room 643 LOB

The Legislative Commission on Global Climate Change met on Wednesday, January 16th in Room 643 of the Legislative Office Building with Representative Pricey Harrison, Co-Chair, Mr. Garrou, presiding. Other members present were: Sen. Albertson, Sen. Cowell, Sen. Pittenger, Rep. Allen, Rep. Underhill, Rep. Wilkins, Mr. Clark, Dr. Eggers, Mr. Tim Toben, Mr. Urlaub, Mr. Robert Glaser, Ms. Tompkins, Ms. Choi, Mr. Everett, Mr. Howard, Mr. Nelson, Mr. Peele, Mr. Profeta, Dr. Riggs, Ms. Preyer, Mr. Slocum, Dr. Smith, Mr. Stephenson, and Mr. Ebert.

Mr. Garrou called the meeting to order to order and asked Mr. Givens for remarks or explanation of the agenda items.

Mr. Givens: Thank you Mr. Chairman I have a number of things to discuss with you this morning. First of all I encourage all the members to sign the reimbursement forms and send them up to the clerks. For the visitors in the back, I encourage and ask you to sign the visitor's registration sheet (**Exhibit A**) which is on a clip board back there somewhere. With regards to some things that you need to know regarding the February meeting which will be held in connection with the Emerging Issues Forum and the focus of that forum is on energy and that will be February 11th and 12th. You have at your place an invitation (**Exhibit B**) from the Forum as well as a one page sheet to tell you how to register. If you are a member of the Legislature, your registration fee is comped by the form. If you are not a member of the legislature, then you will need to pay the registration fee for government officials and that will be reimbursable with a receipt in connection with your request for reimbursement for attendance of the February meeting. I don't want to pay for registration fees for people who don't want to attend. So I encourage you to be thoughtful about it, this is the February meeting and so I hope you will be able to attend both days, registration fee for government officials is $200 and again that is reimbursable. My concern is that the form registration will close when they receive their maximum projected attendance for enrollment. They indicate that will occur this week. You can register online, now I make this invitation in particular to members of the Commission because it is our February meeting but this forum is open to any one in the public and if you're back there in the back and would like a copy of the invitation we have plenty to hand out to you. Now there will be a business meeting of this Commission in connection with the forum. That is the only part of the forum that you don't have to register or pay a fee to attend. If the only thing you are going to do is come to the meeting of the Commission, you do not have to register. Because it is a public meeting it will be accessible to folks who don't have the badge to attend any of the forum events. That business meeting will be held from 2:30 – 3:45 in Room 2 at the McKimmon Center. The purpose of that meeting is to hear from the chairman of the International Panel

on Climate Change, Dr. Pachauri. This is I think a major accomplishment for this Commission. Dr. Pachauri is a Nobel Laureate this year for his work on climate change and the way this is going to work is this: there is an agenda item on the agenda today, agenda item 6 which will be Commissioner Eggers who will outline for us the most recent report from the International Panel on Climate Change. That is by way of preparation for the February meeting and we are doing it this way for this reason. We will have our meeting and we will have Dr. Pachauri with us before he addresses the forum, he actually addresses the forum at 4:00. Ideally he would address the forum and then we would have our meeting and we could have a question and answer session but we could not schedule that. So the thought process here is that today you will get an introduction to the most recent report of the IPCC. I hope that at any point doing that discussion or any point after this meeting if you had any thoughts about questions that you would like Dr. Pachauri to address or issues you would like for him to explore in particular when he meets with us, if you will let me know, I will communicate that to him. I am not communicating with him directly but with three first persons, but the invitation is out there. We want to make the best possible use of the hour that we have with him. So we are going to prepare for that today. Please plan on attending that whether or not you plan to attend any other part of the forum. If you don't plan to attend any other part of the forum you do not have to register and you do not have to pay the registration fee. If you wish to attend any part of the forum, you do need to register and that is either comped or reimbursable, there is a little wrinkle on the comped for a couple of people I'll be around to see you individually. There is a dinner Monday night for invited guest to the forum and all of you who are members of this Commission fall into that category. They are supposed to send me a letter which I will forward to you if you are going to attend the forum you should plan on joining us for dinner Monday evening. I will do my best to answer any additional questions. We have a handout for you which comes from NC State Alumni magazine (**Exhibit C**) and in it a brief article about Dr. Pachauri, his picture is on the cover and it's a question and answer interview type format.

It will be necessary for various logistical reasons to reschedule the April meeting. I am hopeful that we will have a proposed date later in this meeting. We are doing some checking right now, once the co-chairs and counsel have agreed upon an option of dates we are basically looking at the week following the week we have scheduled. We will try to put that out there and I would be interested to know if there are conflicts. You can be checking your calendars and thinking about that. We are going to try to settle among ourselves up here on the week of April 21st. I regret it is necessary to reschedule but it is.

There will be various handouts during the day I know Sen. Pittenger has something he wants distributed and he will undoubtedly hand it up here to us so we read it into record and distribute to you later. There is a document that is his with the words draft (**Exhibit D**) that should have been distributed to you. It is a legislative proposal to prepare North Carolina's agricultural and forestry sectors for emerging carbon market place, this comes from the Environmental Defense

and the Nicholas Institute. Now here is our basic plan as things now stand. We have today's meeting and I think the agenda (**Exhibit E**) is fairly self-explanatory. We are going to talk about mitigation strategies. For some of you the term mitigation may be confusing and mitigation sounds like adaptation, it is my understanding and there are others of you that know more about this than I do. We use the word mitigation when we mean ways to mitigate the impacts of carbon emissions or reduce carbon emissions so as to mitigate or reduce them. Adaptation refers to what we do in response to whatever global climate change is occurring. There have been a lot of interest and talk about adaptation so we have a good adaptation agenda item for you today.

The report from the Frontier Group which is associated with the public interest research group is very (inaudible) request of the co-chairs and then Dr. Eggers item as I indicated earlier. I've just described to you the February meeting. At the March meeting we intend to return to consider of proposals Mr. Peterson will give a very brief report on his efforts to streamline the presentation of those so that we can do that more efficiently. We will consider the proposals from Nicholas Institute and Environmental Defense and others that come our way. That will get us through March and then we will see about April and May. As things now appear, it seems very likely that we will continue this Commission for at least one more year to 2009, I've had some conversations with the leadership and as I've been saying all along, we didn't get into the climate change problem in a year or two and we will not get out of it in a year or two. There is some thought that we ought to develop a more permanent institution but the thought is that would best be done in 2009 for reasons that may be obvious to you. Those are the points that I think I need to cover. I may have more particulars on the date of the April meeting. I'll be happy to answer any questions.

Mr. Profeta: Thank you Mr. Chairman I just note that I don't see that document is distributed yet but we will make sure it gets to your desk before we're done here.

Mr. Givens: I thought it had been but I think I have the whole pile up here and we'll correct that right now.

Mr. Garrou: Dr. Riggs I am so glad you are here today when we're talking about adaptation. It would have been very disappointing if you had not been here.

Dr. Riggs: (Inaudible)

Mr. Givens: That appears on the back of your agenda under schedule of future meetings, it is Monday 11 February with the business meeting from 2:30 – 3:45 p.m. That is actually doing a breakout session of the forum. That will be in Room 2 of the McKimmon Center. While I'm talking I did have one other thing – some people do call in and let me know about their membership status. Mr. Cecich indicated he could not be here today and I appreciate knowing that. I want to introduce the Commission to Mr. Lewis Ebert who is president and CEO of the North Carolina Citizens for Business and Industry also known as the North

Carolina Chamber of Commerce. Mr. Ebert joins us in that capacity and also Douglas Crawford-Brown has indicated to the Commission that he will need to be replaced, actually I think he can replace himself since he holds this position ex-officio, for personal and family reasons he needs to reduce his demands on his schedule. So I have invited him to select his own replacement as provided by the session law.

Mr. Slocum: (Inaudible)

Mr. Givens: Yes sir for members of this Commission it is reimbursable as an expense because it is in effect an official activity an assignment if you will, for members of the Commission to attend if at all possible. No sir you should put it on the form for your February meeting. You will need to attach the receipt.

Mr. Tad Aburn: (**Exhibit F Slide presentation attached**)

Dr. Riggs. Thank you very much for the information. Most of your discussion dealt with greenhouse gas reduction emission reductions but over and over again you mentioned your aggressive approach and the risk of your coastal system. Could you give us some examples of what Maryland is doing with respect to the coastal portion and what does aggressiveness mean with respect to that.

Mr. Aburn:

Representative Allen: Thank you Mr. Chair and thank you so much Mr. Aburn. What did you say the percent of coal being used in Maryland was? Was it seven or seventy percent?

Mr. Aburn:

Mr. Glaser: Thank you Mr. Chairman. Mr. Aburn thank you for coming down with us. Mr. Aburn you referred a couple of times to the science behind an 80-90 percent reduction by the year 2050 and a difficulty in measuring what specific goals you recognized at the end. Where is that science coming from? Is that agreed upon science or is that what your commission sort of settled on as a target goal. That's the first question, the second question is do you have examples of any information relative to the cost of implementing, what type of cost is burdened by the consumer, what type of cost is burdened by the government, what type of cost is burdened by the federal government? Thank you.

Mr. Aburn:

Mr. Glaser: Mr. Chairman, if I may follow up? If I could, what I was looking for is what type of cost, you know when you talk about putting a goal in place by the year 2015 or 2012; some body is going to have to pay that cost. I know with automobiles and transportation there is an increased cost. But I assume there

has been some discussion in the state of Maryland in the Maryland Legislature about this and what I was looking for is what examples did the legislature discuss as far as the exact cost on the consumer?

Mr. Aburn:

Representative Wilkins: Thank you Mr. Chair. Mr. Aburn I would be interested in knowing the total number of employees in the Maryland Department of Environment and I would be interested in knowing if your commission has had any discussion about what the effect on that number might be?

Mr. Aburn:

Representative Wilkins: I would be interested in that information and I believe other folks in this room might be as well. Thank you.

Dr. Smith: Thank you Mr. Chair. Appreciate your presentation, two things one building off this cost question and this may be more appropriate for adaptation follow up, have you tried to quantify the impacts to Maryland in the form of sea level rise, salt water intrusion into fresh water drinking supplies, other potential impacts from storm surge. How much has the state really gone to the effort to have an ability to know what this ultimately is going to cost because when we're looking at the cost equation there is not only the direct cost of implementing these programs but the cost of inaction can be many, many times that and moving forward. So I am just curious about how much do you feel like you have a solid figure or how much effort has there been in trying to quantify the impact?

Mr. Aburn:

Dr. Smith: And I was intrigued about how you all have approached the goal question because that is an issue we are struggling with and clearly having the science drive and aspirational goal and be sort of one, and I may have missed this in your presentation, but have you all tried to assemble the policies that appear to be for lack of a better term, sort of low hanging fruit or and see which projectory that puts you on and then try to identify the gap or the delta between and a here we are now, here is where the science is saying and I know you were going to sort of four year checking I think. But how much are you attempting to look at sort of the implemental realistic policies that are sort of on the books or on the way versus the scientific goals in trying to understand the delta there and tweak them to the numbers accordingly. How does that work out in your process?

Mr. Aburn:

Dr. Smith: The 2020 goal does appear, you think, to be somewhat and that's added as sort of things on the books and on the way.

Mr. Aburn:

Senator Pittenger: Thank you Mr. Garrou. Mr. Aburn thank you for being here, Mr. Aburn do you have a formal relationship with CCS.

Mr. Aburn:

Senator Pittenger: Ok are you part of those as well?

Mr. Aburn:

Senator Pittenger: Are you a consultant to them as well?

Mr. Aburn:

Senator Pittenger: You mention a number of proposals that you all were initiating that would pay for themselves in the long run. Has there been a cost benefit analyses for those proposals?

Mr. Aburn:

Senator Pittenger: So it is yet to be determined how they will pay for themselves in the long run?

Mr. Aburn:

Senator Pittenger: The Bakom Hill Reporter, have you read that?

Mr. Aburn:

Senator Pittenger: It had some questions in terms of methodology of some of these cost benefit analyses and I was just curious what you might know about it.

Mr. Aburn:

Senator Pittenger: Ok thank you.

Representative Harrison: Thank you Mr. Chair and thank you Mr. Aburn for making the trip. I just want to follow up on the clean cars piece of your strategy. I assumed you all adopted the California standard which is subject to litigation. I saw in here a reference to taxing energy and efficient vehicles and I want a little bit more detail what you all are doing about the vehicle emissions?

Mr. Aburn:

Mr. Givens: I think I heard you mention that Maryland is projected to have a shortage of electricity fairly soon. Is Maryland a regulated state at this point or deregulated state?

Mr. Aburn:

Mr. Givens: Ok, do you have a public utilities commission left that can address the shortages or how does Maryland propose to address the shortages?

Mr. Aburn:

Mr. Givens: I would appreciate that thank you.

Dr. Everett: Could I just ask one very simple question. It would be your 13th slide on page 7 of our handout, a sampling of state targets. I just don't understand what that table is. If you could just walk through any state across the page and explain Arizona, for instance.

Mr. Aburn:

Dr. Everett: So for the Maryland example you had projected apparently that between 1990 and 2020 you would grow by 50 percent is that the projection?

Mr. Aburn:

Dr. Everett: And then, of course, your goal is to not grow that you would be 25 percent below your 2020 goal so you would cut that in half maybe, is that correct?

Mr. Aburn:

Dr. Everett: So you would still increase, you don't increase by 25?

Mr. Aburn:

Dr. Everett: So the projection as you would have been up 50 percent, your goal is to be down 25?

Mr. Aburn:

Mr. Garrou: Thank you very much Mr. Aburn for coming and speaking to us. Mr. Givens has an announcement.

Mr. Givens: Senator Pittenger has sent forward two press (**Exhibit G**) releases that are contained in a folder the sergeants will distribute that and be made a part of the record. Let me repeat what I've said to you occasionally in the past. Members of the Commission and public to send material to the Commission and

to the staff and we are glad to have it. It does not however become a part of the record unless it is handed up during the course of the meeting and read in so that the clerk can record it as an attachment to the minutes. If you have something you want added to the record, please use that procedure. Thank you Mr. Chairman.

Mr. Garrou: Our next speaker is Kenneth Colburn who is the senior consultant for the Center for Climate Strategies and he is going to talk to us about adaptation in Maryland.

Mr. Colburn: It's a delight for us to be here today. I am with CCS and Bill Dougherty is with the Stockholm Environmental Institute and does a lot of work with CCS. Bill has international experience in adaptation efforts as well. So we are pleased to offer you some initial thoughts regarding adaptation to climate change. The first and foremost concept that is important to recognize is just what new ground adaptation is, not only for the states but indeed for the globe. There is a bit of political legacy to that unfortunately as well. As many of you know, for long periods of time climate change has been viewed as mitigation or adaptation. We are going to work to solve this problem or we are going to just adjust to it. That almost became an article of faith you know, were you of the mitigation state or were you of the adaptation faith. And adaptation was viewed as the capitulation to efforts to try to solve the problem. Now that we've delayed concrete action on climate change long enough that its impacts are beginning to be visible, it is much more clear that we need to do both which is where we should have been all along in the first place. Those of you on the Commission who are readers of Governing Magazine probably saw the recent piece they did on local warming and that also brings home an important point and that is that all adaptation will be local and all the impacts of climate change will be local for states and municipalities. So states have indeed started to act and to get their arms around what adaptation means for their state, what kinds of impacts will they have to respond to and at CCS we have found that the approach was used whereby we gather stakeholders from the state, they identify a number of options, select from those options which are priorities and then dive deep into those priority options. It appears to be a workable model as well. None of those is complete at this point. Maryland is the first one out of the gate, Washington has done a little work, basically Bill will describe for you what is driving adaptation, what characterizes it and how it appears to be best approached and then I will follow up with a little bit of what's been done in some of the states who have started processes. But I'll just leave you with this is all very, very new even in the state venue and indeed globally. Thank you.

Mr. Bill Doughterty: Good morning everybody I think the first thing I would like to say is that it is a real pleasure for me to be here and talk to you a bit about adaptation to climate change. I was involved in the process in which this state here looked at mitigation of greenhouse gas emissions and so I think this topic here of how can the state begin to think about the process of adapting is not only timely but you might even consider it an urgent matter given what the scientists

are telling us about sea level rise and other aspects of the climate regime. I think what I would like to do just echoing what Ken mentioned is try to give you an overview of what I think are some of the key questions that would be worthwhile to consider as you think about tackling the problem of adaptation to climate change. I think some of these initial questions as I see them have to do with what is exactly the concern here in North Carolina? Are they concerns about the effects of climate change on coastal areas, or your water resources, are they related to the impact of climate change on public health issues, agricultural production and probably the list can go on relatively to your own particular concerns that you would bring to the table. Adding on to that is the key question of who exactly are the impacts going to hit? Who is affected by climate change? Are they the priority people, are you thinking about home owners, are they farmers, are they small businesses, large businesses and in terms of how you look at the problem it is important to think about actions that can be undertaken within the near term, say within the next five to ten years you should get the process of adaptation going and actions that would take place far into the future.

Another key question as I see it would be for what purpose is the process would you want to initiate a process of adaptation here in North Carolina to basically raise awareness among key constituents, general public, is it targeted toward major policy changes perhaps even some legislative decisions. What kind of outputs would be needed and this is, I think, a very key question. There was an earlier question by Dr. Smith about the outputs of the Maryland process and one of the key questions you might ask yourself here is the output of this effort, any potential effort in adaptation in North Carolina would be to better understand the impacts. That is to get a handle around the science, what the science is saying about what will be some of the physical impacts on the natural system here in North Carolina or are you looking for something else in terms of perhaps near term adaptation options or even long term policy decisions regarding adaptation to climate change.

And finally, you will also have to tackle with the real world issues of what kind of resources are available relative to the time that you have to tackle the problem, the capacity in terms of your institutional, technical universities, scientific capacity and all the funds available for such an effort. Rainfall runoff reduced crop yields are we talking about an increase demand for electricity to deal with higher summer heat. And finally adapted capacity focuses on what specifically exist in the state to adapt to climate change. Are the institutions prepared to deal with the issue, is the resource legislative based, is the infrastructure that's in place capable of adapting to this change in the climate. When we talk about vulnerability we are also talking about how each of these three enters play with one another. More exposure and sensitivity increases vulnerability while the more adaptive capacity they had that has defected decreased vulnerability for the impact. My sense is that any process that you are thinking about beginning here in North Carolina should really try to focus in all three of those dimensions. I've used the word probably 100 times by now, adaptation, but I never really have taken the time to define it and I hope it has generated a question in your mind,

what exactly am I talking about when I say adaptation. This slide here refers to the IPCC's definition of adaptation and if you will allow me to read it, it says that adaptation is an adjustment in natural and human systems in response to actual or expected climate stimuli or their effect which moderates harms or exploits beneficial opportunities. And that is from the 3rd assessment report.

There are two basic types of adaptation that we can talk about and the first is our economists what is called by analyst economist or reactive adaptation and it basically refers to what people tend to do, what systems tend to do as the impacts of a changing climate becomes apparent. They are reactive they are not planned they are simply what people feel is necessary to do to deal with reality that they are facing. Another is anticipatory or proactive adaptation. Here we are talking about a whole different set of measures that could be taken that focus on how to reduce the potential risk associated with what is known about climate change. And in so far as the process is being considered to take place in North Carolina it's probably a very good focus on the latter type that is anticipatory or proactive adaptation. Now adaptation is also a little different than the mitigation role in so far as the kinds of actions or measures that could be implemented are very different and they are all aimed at not reducing CO_2 emissions but rather at reducing the vulnerability of the communities in your state to the impact of climate change. And as Ken was mentioning, we've been working in Maryland on this issue and we've developed a catalog of potential adaptation actions that could be thought about in the broad sense but specifically for Maryland in the areas of coastal zones, human health and natural resources. And this universe of options is basically populated with about 200 or so actions and we took that as a basic starting point for thinking about how to whittle that down into specific relevant and pertinent actions of the state of Maryland to consider.

This is an extract from that adaptation catalogue, you will see in the left column option numbers 1.1 – 1.10, it actually goes down to page #30. And this is an adaptation extract focusing on the current built environment and infrastructure in Maryland and the second cost on the left focuses on the types of adaptation actions that could be taken. The next three columns focus on some of the evaluation criteria that the stakeholder consultations are focusing on in evaluating each of these options and then there is a place for (inaudible). In terms of a broad outline of the adaptation process in North Carolina the way I think CCS looks at it is that it probably represents the three step process. The first is initial fact finding, I have a very strong sense, although I am not familiar with the lay of the land here in North Carolina, that there is quite a bit of research on the impact of climate change that is going on at your universities and institutions and the first job would be to try to come up with a good sense of what kind of analyses has been done, how has vulnerability been defined, what are the risk, what are the key ecosystems or other systems that are at risk from climate change? The second key aspect would be state (inaudible) giving the opportunity for citizens in the state to come together and think through what makes most sense for North Carolina given your precious resources and the issues that confront you. And finally some sort of report that provides a set of

recommendations that could inform policy makers as they tackle the next big step of actually implementing some sort of program to deal with adaptation of climate change. I think that from what little I know that probably it's a safe bet in North Carolina to think about interest and adaptation focus on these four areas listed here in this slide, coastal zones, water resources, human health, and terrestrial ecosystems. I could be off their science I am not familiar with the work that has been done here, but my sense in the limited review of the literature of North Carolina is that these are probably the big ticket items in this state. With that I'll just turn it back over to Ken to give you some more specifics about what we are doing in Maryland.

Mr. Kenneth Colburn: Thank you Bill. Actually I will try to put that back up, it may be useful in just wrapping up this discussion, I will try to share a few thoughts about how Maryland and some other states have organized their thinking going in. None of these processes have ended yet so we can't provide you with the conclusions of them regrettably. But there are some insights that are emerging. What Maryland did in terms of its coastal zone protection was actually split into two technical work groups associated with coastal zones. One it called its existing built environment and infrastructure and a second being the future built environment and infrastructure. The basic thinking there being we have a whole lot of capital stock in the ground – what are we going to do with it. Some need to be protected, some need to be abandoned or is likely to be abandoned, how should we make the judgments about which is which, how do we deal with the conflicting interest about which is which and so forth. At this stage Maryland like most states is just trying to get its arms around what are the issues and parameters in metrics involved and even contemplating these kinds of decisions. A good example is they have a regulatory regime associated with 1000 ft. barrier from high tide levels. That was taken and instituted in legislation in 1972 and there is a whole different area now covered with the advent of sea level rise and the land subsiding that's occurred in Maryland. So the 1000 ft. buffer is no longer, it is more like a four or five hundred foot buffer. So that has to all be redone – so they are trying to get their arms around these kinds of issues. In terms of the future built environment, of course, the tap there is reasonably obvious. It is how do we avoid getting in a similar situation with our future construction and one of the things that's really emerged as the unified field period in Maryland is the perception that the state doesn't want to get in the business of being the insurer of last resort. You've already experienced some in property and casualty insurance companies deciding to take a pass on issuing coverage in the coastal states probably some here even in North Carolina. In some cases, I think Florida is taking a step in this direction, the state has stepped in to say ok we will cover, keep writing, we'll be your re-insurers. The trouble is when you get a major storm like which we've seen a few recently and there are substantial losses, billions of dollars of losses you're effectively saying that the state tax payers will be the re-insurance mechanism. Now if you do that (inaudible) built, the storm destroys the infrastructure rebuild it at cost, now there is a bigger storm because we haven't adapted a plan for adaptation. You rebuild it again each

time the state being insurer of last resort. Albert Einstein offered that madness is doing the same thing over again and expecting a different result.

If Maryland hasn't nailed down exactly what it is going to do in the adaptation front or at least understands Einstein's position and doesn't want to follow. Maryland also has chosen as Bill indicated here a work group investing human health, safety and public welfare and that includes everything from how to deal with diseases that are likely to occur, we will see more (inaudible) fever and more West Nile kind of thing. What sort of monitoring systems, tracking systems, early warning systems should there be on that front. Right on through public welfare being emergency warning systems, storm events have evacuation plans to help them there. What Maryland has found interestingly enough is one example, is that we normally think of storm surges as representing the biggest threat. Maryland actually had a situation last year or a couple years where major storm surged actually created the biggest problem by being a dam for the outflow for the precipitation on the land. So the flooding occurred because the surge made it effectively a dam and then the precipitation runoff flooded everything on the coast. Who would have thought of that? That is where Maryland is coming down trying to get its arms around the human health, safety, and welfare issues.

Then the fourth group is natural resources in resource based industries. Maryland has a reasonable sizeable agricultural and forestry sector but it has a huge bay community and economy and of course how to protect and continue to have as viable economic sectors those marine, agriculture and forestry industries is also a key issue of this. Preserving the natural resources in and of themselves but there is also the issue of the resource based industries. That's the sectors by which they are trying to identify and precede with options and most of those options are still in the planning stages, not only in identifying what they are, but their content because so little has been done on that front. For example, short term planning isn't linked to long term planning. Different agencies planning efforts – land use versus health and so forth aren't linked together. So a whole lot of this, at this point, I am sure will be recommendations to connect the dots. Another state that is undertaking some planning action is Washington. Washington has used a similar approach to what we just described here prospectively for North Carolina and also for what Maryland has done. The major exception there is that Washington also split off a separate water working group and that makes sense in the state of Washington because its water and snow pack really serves multiple critical purposes for their economy it is not just drinking water it is also a major agricultural industry and also its power sector which is heavily runoff and (inaudible). So three major underpinnings of their economy relate toward they also did an investigation in the water issues.

Finally I will just share a thought about Alaska which is still forming its work groups. In Alaska I am sure you have heard enough about their situation where they have tumbling trees due to melting permafrost. They have communities that are eroding including Native American communities that need to be relocated. And you can imagine the per capita cost estimates are between two hundred fifty

and five hundred thousand dollars per person to relate communities. That's a cost that may or may not be able to be avoided but to the extent that one can plan for it, it can at least be mitigated itself. And as a result of those dynamics in Alaska it is not politically feasible for Alaska to undertake an investigation of mitigation opportunities unless it also undertakes an investigation of adaptation opportunities. So you see that cart is really before the horse or in the reverse order from what we usually experience and anticipate less work on the emissions and then yet how we are going to adapt. How we are going to adapt, this is happening now and what should we be doing to try to mitigate the problem as well. I would indicate too that in identify how they are going to approach it in terms of technical working groups, Alaska is keeping the best wisdom of its state department, they will take that feedback and sort it out and then the state will identify what working groups it wants to emphasize and then we'll go from there with the process that Bill described identifying options, recognizing priorities and investigating those priorities.

And finally we had indications of interest in Florida which would be no surprise due to sea level rise and also in Arizona presumably directed to the fact that water shortages are looming under most climate modeling scenarios. So they want to get their arms around adaptation issues as well. So that is sort of a lay of the landscape a brief scan of where other states are at this point. Thanks very much for having us.

Mr. Garrou: Thank you. Are there questions for either of our guest?

Dr. Riggs: How is Maryland approaching this whole question of outreach in education of a public and political regime that wants status quo from coastal systems that they really don't want to talk about this? Have you dealt with this at all and how are you going forward to get a stakeholder involvement out there in public domain?

Mr. Colburn: The politics in Maryland have not been an obstacle at all. However, I appreciate the question because it is almost an admission on my part. I mentioned the planning side and planning for planning the other thread that falls through almost everything that Maryland has identified in plans to conduct at least their preliminary work carries through the final, heavily relates to public education and outreach. If they have 40 options at the end of the day, I expect unless they do a massive consolidation that on the order of 15 of them maybe as high as 20 will relate pretty directly to public education outreach. And I don't simply mean add to the public materials to the public, it's the sub-sectors of how do all the emergency responsive personnel communicate with each other on climate based events, catastrophic events even that kind of thing. Educating them to coordinate with this damming and outflow kind of issue is an example that we're putting under the heading of public education outreach at this point, very, very critical issue.

Dr. Riggs: Does the general population out there support this at this point and time or is it a long up hill battle that you're facing?

Mr. Colburn: No I think there is a high degree of support. I would yield to Tad Aburn to offer an at the site kind of feedback on that. But we haven't had push back or resistance at all. I would expect that any individual home owner on the coast would say yes I am all in favor except don't touch my sea wall and that kind of issue may come up because my sea wall may affect your frontage in a (inaudible) manner. So Maryland will have to work through those kinds of things. There is also a strong county and municipal government in Maryland that also has to be coordinated close to the state effort. So there is some push and pull there based on history but none about whether they should be addressing adaptation. Wrong answer, I'm sorry.

Representative Allen: Thank you Mr. Chairman this is sort of a follow up to that question. In what way is the development community involved as you're planning?

Mr. Colburn: They're reasonably heavily involved as stakeholders. There are builders on the stakeholders group itself and municipal planners and there may be others that I am not thinking about at this time.

Representative Underhill: Thank you very much you just made an illusion to don't touch my sea wall. Does that mean that Maryland does allow hardened sea wall barriers?

Mr. Colburn: It has in the past and there are some they are trying to move from a situation where that is not the solution and more of what they call softer and more natural barriers are used instead because frankly they are more flexible and adaptable and you don't run into that situation of oops the sea wall didn't work that time I guess we got to build it bigger, oops Einstein issue. In the harbor communities and smaller residential situations there are some.

Dr. Smith: Ken thanks for your presentation. I think it was touched on in your early presentation but can you go back and just talk a little bit more about the process itself as this particular group was established and can we request a list of who the participants are and just a little bit more about the actual process mechanisms that this entity is carrying in its work and if you know a little bit about some insight on some of the other places would be helpful too.

Mr. Colburn: Sure, I wasn't directly involved in Washington so I am not sure how they did that. In Maryland on their adaptation group the Department of Natural Resources is chairing that effort and it formulated the stakeholder group before we were involved with the effort so we didn't have direct input into that. Typically, on these efforts we do, but the only typical I can talk about is the mitigation side. We do provide input into the identification of categories of stakeholders. We don't know the individuals in the state so we leave that to folks convening the

effort. But it is important, let me site a Maryland example where the DNR had thought pretty concretely about the development community, had thought about the planning community, municipalities and so forth, they had almost completely omitted the health community and the emergency response types of folks. So we are building even now, much as Bill described with the 200 options, a list of conceptual categories that states may want to consider in assembling and conducting these plans. So that list will say have you thought of somebody from the building community. Have you thought of somebody from a water company, a power company so that your infrastructure elements are really there at the table because they need to be on adaptation? And then the process as Bill described, here is a set of options that we are aware from other states and other activities, what should be added to that list to accommodate adaptation most effectively here in North Carolina. Take that new and bigger list and say ok what are those options have the most residents, the most effectiveness, the highest priority in North Carolina and that list that is 200 are now 250 might then be whittled down to 40 or 50. And then with the technical work groups on a sector basis really dive into what will be involved with them, where do we stand now, what's the suggested direction and what would the policy actually look like. Would it be implemented legislatively or is it something for which already exist in executive authority and hammer that out and then submit those as recommendations at the end of the day.

Representative Harrison: Thank you Mr. Chair and thank you for the presentation. I was wondering more specifically about the coastal development management issues. It seems like most of these states that are working on this right now are in very much the preliminary stages and haven't actually gotten to the point where they are trying to make hard fast decisions on redevelopment and what kind of infrastructure, so will we be hearing about that in the future?

Mr. Colburn: Yes exactly – they are in the planning stages of what should be the policy by which they make those decisions. What are they underpinning and then I am sure there will be some struggles in the implementation process.

Representative Harrison: One thing specifically regarding Maryland, a part of the Chesapeake Bay, the agreement I think of six states were some of them involved in that or any of the other states involved in that adaptation effort or is that a regional effort there?

Mr. Colburn: They aren't at this point. The metropolitan Washington Council of Governments has been participating as an observer in the Maryland effort on mitigation and adaptation. So they are wise to it as a council of government but they are not undertaking similar efforts yet.

Mr. Urlaub: Thank you for sharing this with us today. I had a question about the adaptation group and the mitigation group or committees. Are the discussions around the policies and exploring policies and the science in the adaptation group, are you set up in a way that's informing back to the mitigation group for

them to possibly reassess or change some of the inputs into their own cost benefits analyses for the policies they looked at. Are you to that point in your process?

Mr. Colburn: I think the answer is yes and no but I can't claim credit for it, it actually goes to the state itself. In Maryland there is a commission that was established more like you all and it created a mitigation working group which is doing all the work that your CAPAG has undertaken and it also established a separate group of stakeholders there is an overlap. It's really different folk with different interest dealing with the adaptation issue. There hasn't been a cross walk to date except in a few specific conceptual issues and features but they both come together to the commission at the end of the day for recommendations to the governmental legislature. I haven't experienced any yet and that may be a function of where the adaptation process is in the game which is still only identifying its priorities is really where they are. In terms of anything technical cost related impacts where an adaptation decision would arguably increase mitigation problems with that kind of thing. Those are potential so I think what you're suggesting is to keep your eye open and indeed that is quite right.

Mr. Urlaub: Then specifically the four groups that are potential groups listed there where would you see energy come into that? For example, what comes to mind for me is rising temperatures raise the temperature of water that is going into a cooling tower of the power plant can cause power lines to sag more than that might have otherwise but they are not cooling as much and so on. And how in your process is there any feedback for seeing that kind of adaptation challenge and need for capital investment back into the evaluation of alternatives like energy efficiency?

Mr. Colburn: There hasn't been any – I don't think there is a resistance to it but it is important to distinguish as well I think between what one might call feedback loops or positive feedback loops because the vector that creates them has the effect of worsening the vector which creates even worse effects. So your example on temperature both from a cooling perspective with warmer water and with ambient air temperatures requiring even more air conditioning, those are positive feedback loops that if we keep doing business the way we are, we'll have more emissions which will worsen the problem which will create warmer water and warmer air. There has not been in the adaptation effort to date any thing as specific as saying how do we address greater sagging car lines or could we leverage efficiency more concretely on the mitigation side to avoid some of those outcomes but I think they are implicit. They are also sufficiently detailed that we probably haven't gotten to that yet in Maryland and may not in this process because at this point Maryland is still trying to get its arms around the issues well enough and it maybe that we are getting into a level of detail of infrastructure or even power distribution infrastructure but not to the level of detailing this is what should be done. Happily most of the utilities are aware of

these issues as well and are starting to already factor in adaptation - George would probably know best.

Dr. Riggs: You've implied that Maryland's way out in front of everybody else in this country, do you have any preliminary reports that would be available to us to help us lay a path and secondly are there other countries in Europe or Australia and so forth that are also involved in this to the extent that Maryland is that we can learn from?

Mr. Colburn: I would be pleased to share with you what we have and thank you for raising that because it is really a follow up to Dr. Smith's question. We would be pleased to share the categories of stakeholders that we've developed and the options that are being developed. They are all actually posted on the web. I didn't mean to imply that Maryland is light years ahead, it is just perhaps first or second out of the gate and it certainly hasn't crossed the finish line. In terms of the international Bill has far greater experience than I so I call on him for response.

Bill: Perhaps just a brief word about how the international community is treating adaptation. I think to date it is fair to say that most of the effort internationally on adaptation has focused on non industrialized or countries that are in process of industrializing, that is non annex one countries. Those countries that are not responsible for achieving reductions in their GHG levels - that is countries outside of Europe, Australia and the Eastern Europe. Now the reason for that is according to the IPCC most of the impacts associated with climate change are likely to fall disproportionately on those who are the least able to adapt. That is the poor countries, Africa and some countries in Asia and so I've been involved in a number of efforts that are looking at how can these countries adapt, places in Africa in particular? So I think that to answer to your question, most of the international focus has been on concrete actions within developing countries although much of the work there is inspired a bit by what industrialized countries think are the mechanisms that measures on possible policy action that could be taken for these developing countries.

Dr. Riggs: Just a follow up maybe a comment – I am aware that the UK is way ahead of most of us, I don't know if they are ahead of Maryland or not but the United Kingdom has done an awesome job at this and I believe Australia is out there and maybe even the Dutch and so forth. I think we can learn from what they've already done in those countries I was hoping you knew a little bit more about what was coming out of those areas.

Bill: Well you're absolutely right the UK has actually a government program on adaptation and it's very much a model for what countries in the developing world can do in so far as it tries to be a one stop shopping source for adaptation to climate change. That is what could farmers do if the rainfall variation is proving too problematic for the types of crops and other areas of the economy? So yes it is a very good example, the UK. I am not familiar with Australia and what they're

doing but I do know that the UK example in particular is one that is being looked at critically in large parts of the world.

Mr. Stephenson: One of the speakers I think had indicated that Maryland was the fourth most susceptible state to sea level rise and is there an indication what one, two and three?

Bill: You might be referring to the slide in which I showed the increase in sea level rise for three parts of the eastern coast. No. Well I think that North Carolina like its neighboring states is very much at risk associated with sea level rise. I don't think I did and I would not characterize it as a fourth most problematic state but it's definitely in an area of concern.

Mr. Profeta: I can check on that – I remember the information, I can't remember the citation but I can track it down. I believe the ranking was first most susceptible was Louisiana, second was Florida, third was North Carolina and the fourth was Maryland.

Mr. Colburn: It would sound right that it is a function of link of coastline and elevation above coastline over large areas.

Mr. Profeta: Dr. Riggs just gave me the back up that I'm right so I feel much better about saying that now.

Ms. Tompkins: Thank you Chair. Do you have any numbers or field for the trend of tourism being affected?

Bill: Well I think any time in a state like North Carolina where you have a very developed tourism industry along your coastal areas. Tourism comes to mind as one of the parts of the economy that could be really hit hard by changes in the coastal regime. In terms of any hard numbers in Maryland I can only say that they are looking at coastal areas in a very focused way as Ken was mentioning not only in what is there now, the existing infrastructure but also what the future stock would be in terms of infrastructure and the plans that would govern developing in the coastal areas..

Ms. Tompkins: How about the tax bases for beach property?

Bill: Not in terms of trends and changes no – the municipalities are quite concerned of course about that and so that is in the back of their minds as they participate in this process but (inaudible) for conclusions regarding trends no and I suspect that we are at an odd juncture where the economic trends driving coastal development are continuing even as the impacts of climate change begin to be felt and there will be some mixing of those two trends for some time, the next five years anyway.

Ms. Tompkins: Thank you.

Mr. Garrou: Thank you very much for your presentations.

Mr. Givens: We did not schedule a lunch break but at this point it seems necessary to do so. Before we do that, I indicated to you that we needed to reschedule the April meeting which is currently scheduled for the 16th the co-chairs and counsel have consulted and we believe that the most appropriate date will be Tuesday, 22nd that is the week following unless somebody has a serious objection to that, we will post that as the next meeting. Anybody have any issue with that? OK so the meeting scheduled for the 16th is rescheduled for 22nd, it will be in this room.

Mr. Garrou: Let's see if we can be back here at 12:50 to reconvene?

Lunch Break

Mr. Garrou: Called the meeting to order at 1:05 and called on Mr. Peterson.

Mr. Peterson. This is a familiar graph (**Exhibit H**) hopefully that shows the blue line of projected emission and the green line of the sum total of integrated CAPAG recommendations where they ought to be implemented. We also have developed and it is in the final report, but we have done a little bit more work to provide it more clarity is the transformation of that into a supply curve and this happens to be for the year 2020 which is one of the two analytical target years we use, the other being 2010. It shows going from left to right the dots are policy actions agreed to by the CAPAG and those that are beneath the middle black line are actions that potentially could on a net basis save money. You see a long stretch in the middle that are very close to zero and then a see starting at the right hand side that start going above zero. So this is what we call greenhouse gas abatement supply curve and that has not all but most of the 53 actions in it. Some are lacking because they were not quantified for one reason or another. Just by way of comparison there is certainly a lot of analytical work going on in many quarters looking at supply curves for greenhouse gas abatement. This is some recent work done by McKenzie and this work is in the process of being updated. This is using international data a slightly different set of methods for the year 2030 and it has a break point at a cost per ton of 40 yeros, I think that's 59 60 dollars US. I wanted to put this slide up so that you can see if this hadn't chopped off, the right hand side, what we're seeing over and over again is an "S" shaped quadratic function of greenhouse gas cost that shows plenty of opportunity for cost savings on the one end and then a long stretch that's at zero or low cost and then a stair step that goes up beyond that. So there is a lot of consistency in these supply curves world wide. We've run supply curves for many US states that look very consistent in terms of shape but every state is different and as a consequence the curves are a little bit different too. What we have begun to do is package things together so that you can have a more consolidated view of the CAPAG actions. This particular wedge graph is portraying the greenhouse gas reduction potential of actions in different sectors

in its draft because we only included in this graph the ones that had a cost per ton analyses done for them and so there are some actions not included here. But I wanted to isolate on the agricultural, forestry and waste sector that is one sector that had a long list of individual recommendations and because it covers agricultural, forestry and waste it really covers three different sectored areas. So it is more difficult to consolidate those individual recommendations into a set of thematic areas than it is most of our other options. But we've done that here anyway and we've consolidated into eight categories the specific recommendations of agricultural, forestry and waste to show how they would cluster together around areas that would logically be combined for implementation. You can see the whole package is a significant wedge in terms of reductions. I've highlighted with the green arrows the larger ticket items so immediately you see there is a set that are significant in size and there are some others that are small in size and this is just in terms of greenhouse gas production potential. We will be doing this for each of the sectors as well as providing some of the more specific notation for these consolidated wedges about what some of the key implementation barriers and needs might be in order for these to go forward. We certainly can also portray for each of these wedges and for each sector the individual supply curve or cost per ton for the individual measures. Again the take away point is there are some areas that cluster together and they are significant in size, there are a few other things that really are not and if you want to focus on the things that are bigger ticket items they jumped out pretty quickly. So this is a work in progress and I believe that we are scheduled to bring back a more detailed analyses along these lines either at the next meeting or in March and I'll be happy to take any quick questions.

Mr. Givens: Let me just comment with regard to what Mr. Peterson has told you. Two things, first of all, if you all have particular items in the CAPAG recommendations that you want him to evaluate in more detail or provide you with additional information, let us know so that we can have whatever it is and we can offer that will help you in advance of the March meeting. The other thing, I'll be talking to some of you individually, I have begun to focus on the questions of how we transition from the recommendations which are broad to actual draft legislation and if any of you who have thoughts on sources of drafts with respect to any of the proposals that are under discussion, we would be glad to see them.

Mr. Glaser: Mr. Chairman, thank you. Not a question particularly on this topic but one of the things in advance of the meeting today, one of the things that I was looking for is any source data or any information on what's taking place in developing countries, specifically Brazil, Russia, India and China relative to discussions like what we're having in Maryland and like what we're having in North Carolina. Do you know of any source that is a good source for global climate change studies or actions taking place in those countries?

Mr. Peterson: The Intergovernmental Panel on Climate Change has a chapter devoted specifically to mitigation or abatement strategies and lots of back up documents that include exactly that kind of data. The status and evaluation of

efforts taking place in other countries including the non-industrialized or emerging economies for developed nations. So that would be one of the best immediate sources. A little bit of that information has been included in this McKenzie work here, this is North America, Africa, Latin America some of Asia; but there are certainly plenty of sources but I think the starting place would be IPCC because there is a formal mechanism for gathering or reporting of that data there. That data is not particularly current or complete in comparison to a lot of other information. Dr. Dougherty is not here at the moment but he does a lot of work in those countries and we certainly could access specific studies for specific countries if you are interested.

Mr. Garrou: Just to add a little bit to that – I've looked at that study, I think the one I saw was a (inaudible) graph and I think this is the same one that McKenzie did and it is very informative. It is very well presented, got a lot of information in one place.

Ms. Preyer: Just a comment on George's suggestion and thank you for the opportunity to maybe provide some ideas about recommendations we would like to see more detail on because time is moving fast and it seems like it will be smart for all of us on the Commission to look hard at that giant package and do some narrowing of things that would be good to talk about in March. Hopefully we will do that and thanks for the offer.

Mr. Givens: Just one additional comment. Mr. Glaser's point about what is going on in the developing world is the exact response to what I was saying this morning. We will note that and pass that along to Dr. Pachauri – he is our source and we are going to have an hour with him so we reiterate, folks who have questions that are particular to the work of IPCC are encouraged to get them to us now or as soon as you can but they will be conveyed to him and we will make an effort to have him prepared to respond to that type of question.

Mr. Slocum: Tom as you move forward on finalizing the CAPAG report I hope that you will also look at the critique from the Beacon Hill group on cost benefit analysis and look to address at least some of the comments that were contained in that study.

Tom: We would be happy to. We looked at that some time in the past when it came out and received a very immediate response from our research team. We have a couple of different universities that looked at it and they would be happy to provide a comment on that. It doesn't affect the results of the process at all.

Mr. Garrou: Thank you Mr. Peterson for your presentation. Our next topic is the presentation of a report on the Impact Measuring the Impact of Climate Change on North Carolina Coastal Resources from Christopher Dumas who is an associate professor at UNC Wilmington. Thank you, sir.

Mr. Givens: As we introduce Mr. Dumas I wish I had given a little more emphasis to this at the beginning. What we are going to hear now is the cost of doing nothing which is the other side of the cost equation that doesn't often get looked at.

Mr. Christopher Dumas: Thank you Mr. Chairman, thank you Commissioners for allowing us to present the results from our recent studies. This is a joint study by several professors (**Exhibit I**) at UNC Wilmington, East Carolina University, and Appalachian State University and we appreciate the opportunity to present our study to you. This is a project that is attempting to look at the potential vulnerability of North Carolina's coastal resources to climate change. This is one of several studies that were funded simultaneously to look at potential impacts of climate change in particular regions of the United States. So not only is there a study like this that I'm going to present today about North Carolina there are also studies on several other regions that have produced or are producing similar reports. Here is a study on Alaska's potential impacts of climate change in Alaska and also I have another one on New Mexico. These are finished, others are still under way but ours is just one of sort of an effort to take the information that we have on global climate change and try to bring it down to a more regional level. These studies are funded by the National Commission on Energy Policy and the Bipartisan Institute out of Washington, DC. Again this is a joint work, East Carolina, UNC Wilmington, Duke Nicholas Institute of the Environment, Appalachian State. Professor Bin is an economist at East Carolina that worked on this study, I worked on this study myself, I am an economist at the University of North Carolina at Wilmington and I might just say that Wilmington is my home town. I am a North Carolina native so potential impacts on coastal resources are very personal for me as well as an issue professionally. Dr. Pouter from Duke University Nicholas School, (inaudible) was unable to be here today he is in Germany apparently working at the (inaudible) Institute for Climate Impact Research. Dr. John Whitehead is at Appalachian State University also worked on this report. The report is available online and I'll have information about that full report not just the glossary summary that we're handing out today. The full report is available online for download and I'll give information about that at the end of the presentation. This is one of several studies under way here is a list of the other studies that are under way, one that I am on impacts of permafrost melt and infrastructure in Alaska. One of the impacts of climate change and water resources in New Mexico and adaptation policy, impacts on forest and air quality in Tennessee, risk to Florida coastal property, impacts on water supplies in Idaho, and impacts on forest in the Upper Rocky Mountains, so our studies on the coastal North Carolina but the efforts are under way to measure impacts at the regional level across the US.

One problem that we are all familiar with today climate change, we have significant impacts on North Carolina coastal resources due to sea level rise; our potential increase in erosion and increased hurricane activity intensity. As you know, extensive development in the coastal zone in North Carolina in recent decades has put more people and more property at risk. Our report focused on

two potential types of impact, sea level rise and an increase in hurricane intensity. Sea level rise can lead to the loss of beaches or beaches for recreation and for shore fishing, also loss property, loss property value damage to infrastructure also loss to recreation benefits, recreation tourism benefits there was a question about that earlier. We've got some information on that to present at this time. And we also have another category of potential impacts hurricane intensity increases. So if our hurricanes become more intensive due to climate change it impacts our business and tourism is interrupted. Agricultural losses damage to forest and potentially also to commercial fishing.

Climate models behind the analyses – the climate model physical science portion of the report was conducted by Dr. Pouter who is in Germany now, so I am going to be presenting this information but I am not a climate scientists, I am an economist. So I am least familiar with this information, I'll just run through what I have and any detailed questions you will probably need to contact Dr. Pouter. We used climate model results from the IPCC third assessment report - the fourth assessment was not available at the time we did the study. I would like to mention that this is an initial look at potential impacts of climate change in North Carolina. We only had six months and $50,000 to do this study. We had no money to gather additional data, we had to use existing data and so this is what we were able to put together from existing data to give an initial snap shot of some of the most (inaudible) impacts might be. We used climate model results from the third assessment. From that assessment we used mid range numbers from the results of over twenty global climate models covered in the IPCC report and there is a list of lots of different climate models, if you're a climate scientist you might see your favorite climate model in there. We looked at all twenty models and tried to pick mid range estimates of changes in precipitation and temperature and sea level rise based on those models. We used the sea level rise inundation model using an eight side rule for connectivity, I have no idea what that means, see Dr. Pouter. They have several studies one under review and others they have published previously about modeling sea level rise that uses light hour elevation data and generated a raster surface, binary flooded. Not flooded raster surface basically means for different property locations along the coast we can determine based on the sea level rise scenario whether certain property parcels were flooded or not flooded as a result of gradual sea level rise. Also there is a separate storm surge model that looks at whether properties might be flooded due to storm surge or intense storm surge due to climate change resulting from hurricanes.

North Carolina is especially vulnerable to sea level rise because our topography is so flat. A one foot rise in sea level can cause inland moving of the shore line by 2,000 to 10,000 feet in some locations in northeastern coastal North Carolina. In addition to sea level rise, we also potentially face the problem that our area of shoreline is also subsiding. So the same time that sea level is increasing our land is slowly sinking. That effect is also accounted for in the model but the subsiding of the shoreline and the increase in sea level rise to obtain a net sea level rise in our area. Here is a shot of the land area at risk to sea level rise

under our different scenarios by 2100. The land at risk is in pink, red and dark red unfortunately I don't have a good shot zoom in on the coastal barrier islands that a lot of large portions of barrier islands are at risk. As you can see the impacts are more pronounced in the northeast where the topography is flatter and less pronounced down in the southeastern portion of the state where the land rises more quickly from the sea. A lot of the coastal barrier islands from the northeast end and the southeast are impacted by sea level. As far as hurricane intensity the physical model behind that we used a modified (inaudible) wind speed model to generate our base line wind speed intensity estimates. We ran hurricanes three times with hurricane tracking information from Hurricane Fran.

We downloaded from the National Oceanographic Atmospheric Administration website. We chose to look at Hurricane Fran – potential impacts of what if Hurricane Fran which folks in North Carolina are familiar with, what if Hurricane Fran became more intense in climate change. We strengthened Hurricane Fran by an amount that the climate model suggest might happen, what if that same hurricane hit but only it was strengthened due to climate change? What would the additional impacts be? We chose to look at that because we thought that was a concrete scenario that people could relate to when we're presenting our results. Of course the impacts of increased hurricane intensity would vary depending on exactly where the hurricane hit and what (inaudible) across the state. The many different possibilities they're modeling methods you can use to look at that, your Monte Carlo simulations and that kind of thing. But given the information that we had at the time and our time I do not have time to do that, we thought this would be a way to measure something that would have residence with North Carolina citizens. Scenarios were based on estimated changes in hurricane intensity according to a study by Newsome and (inaudible) that looked at potential impacts of global warming on storm activity in both the Pacific and Atlantic Oceans and we estimated changes in hurricane formation in our area off the Atlantic Ocean and the area where hurricanes are generated and then we estimated that wind speed, that was to get at our base line hurricane wind speed distribution across North Carolina due to Hurricane Fran.

Then we said what if global climate change happens, how much of this wind speed increase when you use the magic seed spending model to estimate potential increase in hurricane wind speed and distributed those increases a percentage basis spaced across the state as the simulated Hurricane Fran role strengthen Hurricane Fran roles across the state. So this track of Hurricane Fran in 1996 that is the track we're looking at for our global warming affected Hurricane Fran. Hit just south of Wilmington and then moved to the northeast across the state. It had impacts along the state but impacts were most intense down in the southeastern portion of the state.

These are some results of the model that look at what was the base line hurricane wind speeds in different counties in North Carolina looking at four example counties, Bertie County in the northeast, Carteret County, Dare County and New Hanover. What were the wind speeds in those counties caused by

Hurricane Fran and then what would the wind speed be under climate change scenarios? Even though Hurricane Fran was a category three hurricane, it only had category three winds in the eye wall. As you move out away from the center of the hurricane the wind speeds diminish so the wind speeds that are experienced by any particular county depends on where that county is located relative to the track of the hurricane. Some of the counties that we chose to study as examples had less than category three base line wind speeds as they were less affected by Hurricane Fran.

So with this physical science background context we are going to consider the impact of climate change on coastal real estate, coastal recreation tourism and general business activity, agriculture and forestry. We also considered commercial fisheries but there was very little information available on the impacts of hurricane for commercial fisheries so we are unable to present any results for commercial fisheries at that time. We utilized that range of mid range for sea level rise and hurricane intensity increases, not the best or worst case scenarios from the climate models mid range predictions. Our study assumes that no mitigation or adaptation is taking place so we are essentially estimating vulnerability, what might happen if we do nothing.

We had some great presentations earlier today from folks who are thinking about mitigation and adaptation, we're saying what if we don't pursue that and we allow climate change to happen, what might be the impact? I'll begin with recreation impact – this section of the report these results were developed by Dr. John Whitehead of Appalachian State. We have two types of recreational impacts that we looked at – beach recreation and also fishing. So there is beach recreation when you're sunning on the sand and swimming and then there is fishing. For the non fishing recreation, the beach sunning and swimming, we only have good data from southern North Carolina beaches, so for basically Morehead south. We have this data due to another study we did for the Corp. of Engineers a few years ago when we collected onsite survey data, mail and telephone survey data, on recreation that's on these beaches. So we had readily available data we could use to estimate potential impacts here. Similar data are not available for the Dare County and northeast North Carolina beaches. We were not able to estimate impacts there. So the recreations that I present are only for the southern North Carolina beaches, those northern beaches would have additional impacts beyond what I am going to present today. So here is what the sea level rise models indicate with respect to impacts on beach width. We've got some current beach width that's the 2003 column at various beaches in Carteret, Onslow, Pender, New Hanover and Brunswick Counties, then what the beach widths might be under sea level rise from the climate change scenarios in 2030 and 2080. We projected estimates of impact of 2030 and 2080 for the purposes of reporting. So as you see a number of beaches if we do nothing the beach would go to zero, so if we do not re-nourish, if we do not undertake some other types of activities we could lose significant numbers of beaches along the North Carolina coast.

Representative Wilkins: Could we have some idea of what the standard tide was here?

Mr. Dumas: The standard tide I don't know. Are you talking about at what point on the beach would beach be measured?

Representative Wilkins: Yes.

Mr. Dumas: From the line of vegetation on the dune down to mean high tide. So the base line beach width information, the 2003 column, that information is from the Corp. of Engineers we asked them for their beach width and used that in the modeling.

The point here is that the potential to lose a significant amount number of beaches as have a significant reduction in beach width if nothing is done and of course, even if you don't lose the beach if you have a significant reduction in beach width that significantly affects recreational opportunities, that makes beach recreation more congested and also of course if you lose your beach width the beach that protects your structures, the structures are more vulnerable to storm surge.

Impacts on recreation tourism – it provided additional information on economic modeling behind the recreation and tourism results if you are interested. I think Dr. Phaneuf from North Carolina State University could also give you lots of additional information on recreational modeling. He is one of the experts on that Dr. Whitehead is as well. But due to effect of the bottom line loss recreational value to local southern North Carolina beach goers estimated to be about ninety three million dollars per year by 2030, two hundred twenty-three million dollars per year by 2080. Now this is loss value to the recreations themselves. This is a measure of the production in value because they are not able to go to the beach to recreate or they have to go to other less preferred beaches in order to recreate. The model takes into account the possibility that if a certain beach is loss due to erosion, beach goers may still take a beach trip but just may go to some other beach that has been less affected. The model takes into account the substitution affects across beaches to make these impacts. In terms of production annual spending by non-local beach tourist visiting North Carolina, the reduction in out-of-staters coming to the beaches and reduction in their spending could be as much as 16 percent by 2030 or 48 percent by 2080. This significant reduction in tourism as you would expect if we lose these beaches. The annual spending amount calculations we only calculated for non-local beach tourist under the assumption that if you were a local beach visitor if you did not go to the beach you would do something else with that money, go to the movies or something else instead that still might provide economic stimulus for the region. So we only looked at non-local beach tourist to calculate the economic impact on local businesses due to reduction in recreations.

Dr. Eggers: I am a little bit confused, lost recreational value to local southern North Carolina beach goers. You said it was lost value to the individual but then you said that might go somewhere else and spend the money, so is it a contingent valuation thing you did because they are going to a beach that's not as good?

Mr. Dumas: Yes they are going to a beach that is not as good or we're not going at all. So we assume that there is no change in expenditures by local beach goers they still spend that money. There's no impact on local businesses but they have a reduction in value to them because they are undertaking a recreational activity that is less preferred. They would have gotten more personal value out of going to the beach, but if the beach is not there they will of course do something else. So they're still spending money but of less value.

Now we look at impacts on shore fishing – for shore fishing we do have information for all beaches throughout North Carolina. Twenty-eight beaches and 22 piers and information for the shore fishing impact estimate is from the National Marine Fisheries statistics survey and that provided the data that we needed to estimate impacts on shore fishing. If you lose some beach area we assume and used the model to estimate where the shore fishermen will go instead to other beaches or move to the piers and so the estimates of loss value take into account the fact that they will do their next best thing if their beaches are affected they will move to a substitute beach or to a pier and continue fishing. It's just that they enjoy that less than they would fishing in their primary location. So based on the date of the analysis the loss recreation value to local shore anglers fifteen million dollars per year by 2030, seventeen million dollars per year by 2080, these impacts are for all North Carolina beaches.

Coastal real estate – this portion of the study was conducted by Professor Bin at East Carolina University. Again we focused on four counties, here is a map of the four counties, Bertie, Dare, Carteret, New Hanover, these results only apply to property values in those counties. We have data on property values from the county tax office, parcel level data for each individual piece of property. We also have high resolution light elevation, ground elevation data to identify areas that would be inundated by sea level rise or storm surge. We also have other characteristics of property parcels distance from the shore, etc. measured using geographic information systems from GIS data. For example, here is some of the data from New Hanover County, property value of the town you're in, size of the house square footage, age of the house, bathrooms, fireplace, ocean front or not, down front or not, many different types of information used to estimate what the value of the house and the value of the property and how much of that value might be lost, what value of the property would be lost if it were in there? The picture of the (inaudible) data shows elevation data, looking from the ocean, looking back toward the coast and showing the elevation of the houses and trees and the ground.

Here are some examples of the geographic information system real estate data we've got the elevations data, ground elevation data at the top right, distance from the shore line data at the bottom left and tax parcel Centro data to the bottom right. Centro is the central locate geometric center of your piece of property. So as sea level rises or storm surge happens if the geometric center of your property is covered by water, then we consider that parcel flooded. We considered several (inaudible) scenarios, again looking here at 2030, 2080 a low, medium and high in projected sea level rise so in 2030 based on our global models, projected sea level rise could be anywhere from 0.1 to 0.2 meters along the coast by 2080 it could be from 0.3 to 0.8 along the coast. Here are some inundations flooding maps for 2080 the high scenario so out by 2080 you look at the areas that are shaded dark blue and light blue. Dark blue those are the areas that could be flooded again. This map has some call outs that you can see the effects on the coastal barrier islands in the bottom right as you can see the barrier islands are significantly affected and harder to see in the large scale map to the left but you can see there are some significant affects. Also there is some property that is affected well inland around the estuaries and sounds and also up the Cape Fear River and its tributaries. These (Inaudible) properties value model a common type of model economists use to estimate the impacts on property values, estimate the loss of value due to flooding. Current property values are subject to sea level rise in New Hanover County. Look at New Hanover County as an example we have similar results for the other three counties in the study. On the left you can look at the first column property value, current property value that's in millions. New Hanover County has 16 billion dollars in property value with a split between residential and non-residential value and then you can look at the loss property value for the various sea level rise scenarios in the columns moving to the right. So if you look at the far right column that is the worst case scenario out in 2080 New Hanover County could move 227 million dollars in property value or about1.4 percent of the existing property value in the county, of that about ¾ residential and ¼ non-residential losses, 1.4 percent of the value of the property and 1.3 percent. Now the percentage of coastal property or the property on the barrier islands loss is much higher, that percentage is a total property value in the county.

Here are similar results for Dare County and if you look at the top right percentage of the total county property value loss it could be as high as 19 percent in the worst case scenario, or 3.5 billion dollars in property value. Dare County is very low elevation and has significantly greater impact than the counties to the south like New Hanover County where land elevation rises much more quickly as you move from the sea inland.

The estimates of the property value at risk in the future in which year the damage occurs impacts the estimate of the property value loss and also the discount rate that you use. So here is a table that shows the potential impact of the economic discount rate you used on the damages that have been filed in the future. For example, look at residential property value at risk to New Hanover County, look at the bottom row, the undiscounted measure of property value at risk under the

worst case scenario the bottom row 2080 with high sea level rise, 254 million dollars with no discounting that's the value of damages occurring in 2080. However, if you take those dollar damages occurring in 2080 and discount them to present day dollars instead of being 354 million it is about 60 million dollars in damage. If you use a 0.7 percent discount rate the far right column. So the discount rate that you use affects the present value of damages that might occur in the future. So the value of property at risk to sea level rise in just four of the coastal North Carolina over the next 75 years is potentially almost seven billion dollars, the present value of the loss residential property in 2080 is 3.2 billion and when you discount at a rate of two percent. The present value of loss non-residential property is about 3.7 billion when you discount at a rate of two percent. If you discount at a higher rate then the losses are smaller.

I'm going to talk about impacts of increasing storm intensity on coastal North Carolina. This is my section of the report – again we are going to look at the impacts of increasing storm intensity in just four counties. You look at those four counties and look at the track of Hurricane Fran and say what if a hurricane with a track similar to Fran came through the state but was more intense and was increased intensity due to climate change, what might the impacts be on wind speed in the four counties? The base line wind speed caused by Hurricane Fran in the four counties are shown in the first column, tropical storm in Bertie County, a category one in Carteret, tropical storm in Dare and category two in New Hanover. If we have a climate change occur by 2030 and 2080 if that same storm came through that was more intense, you would have an increase in wind speed in some of those counties. Bertie County not much effect, tropical storm winds all the way across even with climate change due to the particular track that Fran took in this particular scenario that we're investigating. If we had more time and more money it would be much better to do a Monte Carlo study with all possible tracks of hurricanes across the state and estimate probability distributions of damages and that type of thing and that would be a much better study because of the initial snap shot.

Carteret County - if Hurricane Fran came through again with more intense instead of experiencing category one winds it would experience category two winds. New Hanover County did experience category two winds on average across the county and it could experience category three winds, so if the hurricane came through and intensity was increased what would the additional damages be? In our study we are going to assume that the frequency with which hurricanes strike North Carolina remains unchanged under climate change. Now when climate change occurs it could both increase storm intensity and increase hurricane strike frequency, the number of strikes per year or decrease the number between strikes. But the information that we had at the time did not provide information that would allow us to estimate changes in hurricane strike frequency even though we wanted to do that we discussed that extensively we could only estimate changes in intensity. If you assume that the hurricane strike frequencies remain as they have been based on historical record in North Carolina, you can see in the last 150 years you've been struck by 23 category

ones, 13 category twos, 11 category threes, and so on, Hurricane Hazel our category four that struck in the early 50's. From basic information calculate the annual frequency, the annual probability of annual chances that North Carolina will be struck by a hurricane of a given frequency. We're looking at hurricane category three, Hurricane Fran and saying what if category three hurricanes strike with the same chances every year about seven percent for a category three based on historical record but the hurricane strikes become more intense.

The first category of damages is business interruption. So business interruption are damages that result when you have a hurricane strike that is not a major storm, it is not a category four, not a category five, you don't have buildings being knocked down instead you just have downed power lines, downed trees, flooding that prevents businesses from operating as normal for a given period of time. By chance we've done a study on the economic impacts on business interruption of low intensity category hurricanes in North Carolina of a few years ago. We looked at Hurricanes Bertha, Bonnie, and Fran categories one, two and three and we did a survey of businesses in North Carolina asking how many days did it take them to return to full normal business operation following strikes by each of these hurricanes. So by business industry type we could estimate how many days it would take to return to full operation. Now this is important for the current study because our estimates of the impacts of more intense hurricanes on North Carolina involve switching among categories of low intensity storms. Some counties go from category one to category two, some from category two to category three, so most in this state we could estimate what are the additional number of days that businesses might be out of business having their business interrupted due to hurricanes becoming more intense under climate change. In addition to these data we also have information on the dollar value of output per day by county for each of these industries. Those data also take into account the fact that different counties have different industries present and those different industries present in different magnitudes. Dare County might have much more in both buildings for examples than Bertie County so we do account for the difference in industry mix across counties.

Benefit interruption losses – just four North Carolina counties, Dare, Bertie, Carteret, and New Hanover. We are not including agricultural, forestry or commercial fisheries at this point. So what might an impact be due to an increase in category hurricane three, Hurricane Fran severity only? So it could be a 34 million dollar increase in business interruption damage per storm per category three impact by 2030 and 157 million dollar increase per storm strike in 2080, just in these four counties, just for business interruption, just from category three hurricanes. If category fours and fives also become more intense and there will be additional damage for that. Also this assumes that it strikes frequently or remains the same that hurricanes also come more frequent and that would increase the damage further. Cumulative impacts for 2004 to 2080 given the probability that we are struck with category three hurricanes every year what might the impacts be by the time we get to 2080? Just due to the increase in intensity from climate change - 373 million dollars assuming no population or

income growth along the coast. If you use the state's projections of population and per capita income from the coast, it could be 1.4 billion dollars accumulative impact due to increased intensity category three storms on just those four counties along the coast. I know that statement had a lot of caveats in it but we are restricted by the limited amount of data. We hope to expand these results to account for change in hurricane frequency and consider more counties and more detail in the future.

Impacts in agriculture – there was some information available for North Carolina Agricultural Statistics Service on the impacts of hurricanes that have struck North Carolina in the past. So for example in category one hurricanes, there have been multiple strikes on average, a category one hurricane has 50 million dollars in damage, category two – 200, category three – 800 million dollars in damage. So you can see that potentially a change in hurricane category due to global warming, a change from category one to category two. It could mean significant additional damage to agriculture in the coastal region into hundreds of millions of dollars per storm strike.

Impacts on forestry – less information is available on the forest sector. There were two main studies that I was able to use that were produced by the North Carolina Forest Services Timber Damage Assessment. A study on the impacts of category two Isabel in North Carolina which did 578 million dollars in damage and category three Hurricane Fran that did 1.5 billion dollars in damage to (inaudible) to forestry in North Carolina, so based on this limited data you say well what if storm intensity increases from category two to category three, you could have hundreds of millions of dollars in additional damage to forestry in the state. That incremental impact may be smaller based on these data because of the technicality that Fran may have cleared out some weaker trees leaving fewer trees to be damaged by Isabel that came later in time; if so the incremental impacts of an increase in hurricane severity would be smaller than is indicated by looking at these numbers. I am just going to give you a ball park estimate of the significant impacts of increases in hurricane intensity on forestry. If you look at the potential impacts on climate change on North Carolina's coastal economy potential impacts of the next 75 years, loss recreation benefits could be on the order of four billion dollars. Property at risk and sea level in just four counties could be on the order of seven billion dollars, business interruption, agriculture and forestry losses could also be substantial. And again this assumes no increases in storm frequency, we look forward to results from climate and weather modelers that are improving the modeling and can give us an estimate to changes and frequency. Some of that work is going on at some of the universities in the western part of the state. Also these are potential impacts assuming no adaptation or mitigation. These results facilitate comparison of policy cost in benefits. Avoiding potential impacts that I am presenting here today would be one of the benefits of adaptation and mitigation costs.

So if you look at the cost of some of the adaptation and mitigation policies that have been identified by some of the speakers earlier today, look at the cost of

those and you think well what might we be getting for implementing these adaptation and mitigation policies, what might we get from incurring these costs? Well what you would get is you would be avoiding some of the damages that I've discussed today. I am very happy to report that the University of North Carolina Research Competitiveness Fund has recently been established and has just approved funding for additional research on this topic, North Carolina coastal hazards, economic implications of severe storms and sea level rise, a significantly larger budget and time line with respect to our project for a 288 thousand dollar study. It is joint work – East Carolina University is the lead, Professor Steve Culver and Stan Riggs are the principal investigators and also includes investigators from Western Carolina University, Appalachian State University, UNC Wilmington and the Coastal Studies Institute, it's a North Carolina wide effort. That report was due with initial results not reported, we will do that this summer and results are already under way. I had a one page handout (**Exhibit J**) that I passed around showing the projected deliverables from that report. If you're interested in what topics that report might consider you can look at that one page sheet. Not only does it look at some of the items that I've presented results on today, it also considers traditional issues like highway 12 and the Bonner Bridge and historical sites and (inaudible). So there is not only information on extending our results but also new types of impacts to be considered by this new study. If you're interested in the full technical report instead of just the four page glossy (**Exhibit K**) I've passed around today, that can be downloaded in its entirety from the website at Appalachian State. I would also like to say that North Carolina is left with a lot of work in natural hazards and climate change and we have a lot of folks working on this. Not only the folks I've mentioned today in this presentation, let me also point out the Natural Hazard Center at East Carolina University. They have gathered together a lot of great scientists and economists there and doing a lot of great work on coastal hazards, economics and physical science. In addition, the Duke University Nicholas School not only has great physical scientist, one of who was a member of our team and also some great economists including Dr. Marty Smith who is working on the dynamics of erosion, taking dynamics and we're expecting much more details than we've been able to look at in our initial report. North Carolina State has put on a great national scale workshop on economics and climate change here in Raleigh this past fall. We had folks from all around the country coming and presenting information on economics and climate change in the region. One of the highlights of that workshop in addition to what is going on in our state was a presentation by Professor Michael Hanemann from the University of California in Berkley. He heads the Center of Study for Economics for Climate Change in California and if you're looking for additional information on what is going on in California in the economics climate change I would highly recommend that you goggle Michael Hanemann at UC Berkley and find out what is going on there. And finally a commission member asked a question of the last speaker about where you might find additional information on economics of climate policies in other countries and developing countries? I might just mention Resources for the Future, another think tank located in Washington, DC that does a lot of work on natural resources and environmental economics. They have a lot of great work

on economics of global warming and climate change, not only US but around the world and they can provide additional information and additional links to other researchers around the world. With that I conclude. Thank you.

Dr. Riggs: Thank you very much for your summary presentation. I would like to ask two questions. One more specific that deals with growth rates on the coastal counties is outrageous, 40/50 percent annually so that if we project forward to 2030 and 2080 assuming that we have no limits to grow as we proceed, not only do the increasing population but the changing economics of who is building there and the big industries that are coming in and the size of the mega houses etc., it seems to me that your numbers are incredibly conservative. Have you taken into consideration or do you plan to take it into consideration those changing dynamics of growth that's question number one. Question number two, I would like to hear what you would do in phase two here assuming we can make money come available what is your next step and how do you expand this into something more than just a snap shot?

Mr. Dumas: With respect to the changes in growth over time there are several dimensions to that issue. One is that we calculated all of our results so assuming no growth to population per capita income and assuming state projections and it is true that those projections could be optimistic in terms of population and per capita income if you assume there's been some caring capacity because we run into limits. So we hope that our results that we provide sort of span the range of possibilities with respect to income growth and population growth. And we expect an increase in value that is why we also included changing per capita income. So our projections not only include for change in (inaudible) growth population but also per capita income to get us that wealth effect the fact that people might do due to increases in income build larger houses as they are doing along the coast. We also grow because of the county economies but we do not change over time based on change per capita income. We grow in value with the industries in each of the counties over time. We do not change the industry mix. Of course industry mix is likely to change over time but that is difficult to predict so for the purpose of our study we just withdrew industry mix per capita income. With respect to changes, additional issues about investigative (inaudible) budget and additional time there are several. One is we would collect beach recreation information for northeastern North Carolina similar to the type of information we had for the southern beaches. The Corp. of Engineers has such a project and ready to go. We helped them design it, we have the survey. We have the sampling plan already to go and the Corp. was about to do that but then their funding got cut. So we hope to implement that study so that we can also estimate the impacts on beach recreation in the northern part of the coast. As you know tourism recreation is a large and growing important industry. With respect to property – property value and property value at risk due to sea level rise and storm surge there are several things. One would be to extend our results to all coastal counties not just the four counties we considered, that would be one thing. The next thing would be to look at better modeling of storm surge. We feel good about the sea level rise modeling that we have done, the storm

surge modeling could be improved based on existing information based on state storm surge maps and (inaudible) model which you may be familiar with and we could improve the storm surge modeling. Also we would really like to (inaudible) property with respect to business interruption, effects on agriculture, forestry and also potentially property. We would really like to get our hands on better storm frequency information. If climate change happens how is it likely to affect the annual chances of different areas being struck by different intensity hurricanes? So essentially we would like the weather modeler to provide us with shifts in the wind speed distributions that North Carolina might experience over time due to climate change. If we had those shifts in wind speed distributions we could then calculate estimates of probabilities in terms of types of damages happening and confidence intervals and those types of things that might be valuable to policy makers who are in risk management situation. We all know that there are no certainties here just the climate are large complex dynamics (inaudible) system and it is difficult to predict. So we are trying to manage risk to the extent that we can provide estimates of probabilities and chances and complex intervals that make our results more useful in balancing benefits and cost of managing risk.

Representative Underhill: Thank you just one quick question. You mentioned the workshop that was last fall and opportunity to look over those materials if we were not there. Could you elaborate on that again, I'm sorry I just didn't follow on how to do that? Is it online?

Mr. Dumas: Sure, the workshop last fall hosted by North Carolina State University and they invited economists from across the country to talk about recent studies of economic climate change in their region and at the national level. You can find links to that workshop at the North Carolina State University Department of Economics or Agricultural Economics more likely. They have an environmental economics program there.

Mr. Slocum: Just a couple of comments with regard to the forestry sector. When Hurricane Fran hit it was in a period of pretty unusual circumstances. The hurricane hit following a fairly prolonged wet period, soils were saturated and that really exasperated the damage from the hurricane. The other thing is timber damage from a hurricane is dependent on a lot of different factors, timber size, age, soil type, soil moisture all have a dramatic impact and I would just caution against trying to model the forest as a uniform entity with regard to storm damage because it is not uniformly susceptible and your damage is not going to be uniform. In fact it is very seldom that you have state wide damage from any single storm.

Mr. Dumas: That certainly is the case so we were just trying to look at what order of magnitude effects might occur. We had changes among hurricane category based on the existing information. We did not undertake any detailed modeling on the forest sector because we didn't have the information to do that. As you point out, not only would the impacts be affected by differences in the physical environment, the biological environment at the time, that the value of the

trees lost would also be affected by what is going on in the lumber market and the housing market and all types of things that effect the price per board foot for different types of trees. So the value lost depends on many different things and it is not only location specific but it is also time specific in terms of different values market would place on. Better to be hit when you're in a recession than when you are not I guess.

Mr. Garrou: Our next presentation is from Mr. Travis Madsen, who is a policy analyst with the Frontier Group.

Mr. Madsen: Hi my name is Travis Madsen. I am a policy analyst with Frontier Group which is a nonprofit organization and we have offices in Boston, Baltimore and California which I'm visiting you from. So I appreciate the opportunity to come out here and speak to you about a report that I've just written. Frontier Group produces policy ideas and research in support of cleaner and healthier environments and a fair and more democratic society. Since 1996 our staff includes about 100 research reports addressing various topics from energy use to global warming to public health. I am here to talk to you today about our recent report called "When It Rains It Pours Global Warming and the Rising Frequency of Extreme Precipitation in the United States" (**Exhibit L**). First I am going to talk briefly about what climate scientists expect global warming to do to precipitation patterns in the United States. Then I am going to briefly talk about our study which shows that some of these impacts are already visible. I'll talk a little bit about the impacts if this trend continues in the future and then present some brief policy recommendations.

As you heard scientists are using climate models which predict what might happen in the future of different scenarios for global warming emission. As far as precipitation patterns go they expect that global warming will have a huge general effect. Some parts of the United States will receive greater amounts of rain and snow fall during the course of the year. Some parts of the United States will receive less but in general across the whole country scientists expect that more of our total annual precipitation will come in a smaller number of storms during the year. In other words when it rains it's more likely to rain harder. At the same time in between these more intense rain storms scientists expect there will be longer periods of dry weather. Let's talk about the precipitation intensity – the idea is that when it rains it's likely to produce more rainfall. This figure that is up on the screen is from the latest Intergovernmental Panel on Climate Change Report. On the left hand graph there presents precipitation intensity over time, the left side of the figure is historical information and the right side of the figure presents model results from different emission scenarios into the future. Precipitation intensity in this figure basically represents total annual rainfall divided by the number of days during the course of the year when you have precipitation. Basically what it shows is that if global warming progresses over time you can expect to get more of our rain coming in a smaller number of storms. In other words, the frequency of extreme rain and snow storms will increase. The right side of the figure, the map, shows one possible scenario for

around the year 2090. Across most of the world in fact, precipitation and intensity is projected to increase. That is especially true for temperate parts of the northern hemisphere including the United States. There are two main reasons scientists believe that this fact will happen. First is because of the warmer temperatures caused by global warming, evaporation rates will increase. So water will evaporate faster from the land and from the surface of reservoirs and rivers and from the ocean. Second, warmer air can hold more water vapors – so from satellite measurements scientists have found that for every degree Celsius increase in average temperature in the air, the air can hold about seven percent more water. In looking at satellite data over the ocean over the past several decades scientists have identified an increase in the amount of water vapor, it's going up by about 1.2 percent per decade. They are concluding that fact is primarily due to human emissions of global warming pollution. These two factors combined to enable clouds to hold a greater amount of moisture which then leads to an increased likelihood of extreme participation.

Scientists are also predicting changes in overall precipitation patterns. So across much of the United States including North Carolina the predictions for a slight increase in the total amount of annual rain and snowfall. In other parts of the country including the Desert Southwest predictions are that it will become drier. In fact that this trend has already been documented in the scientific literature, a recent report by Environment Canada showed that the annual rainfall totals in temperate parts of the Northern Hemisphere have been increasing since the 1920's. Again this impacts their primarily assigning to human emissions of global warming pollution. Additionally the distribution of rainfall during the course of the year is likely to change. In general summers are likely to become drier and winters are likely to become a little wetter. On the other side of the coin of increased precipitation we have an increased likelihood for drought. So in between the more frequent extreme storms that we are expecting we are also expecting that global warming will cause extended periods of dry weather. So this is again a figure from the Intergovernmental Panel on Climate Change report from last year.

On the left hand figure it shows the number of dry days during the course of the year and the left side is historical information and on the right side is projections for what could happen in the future. Under one scenario of global warming which is a scenario for intense emissions called A2 up on the figure, the surface area of the earth that can be subject to severe drought conditions could increase to about 30 percent of the land mass of the globe. That is compared to about one percent of the globe today. This brings me to the research that we did. We looked to see if we could see changes in precipitation intensity using weather records from the (inaudible) United States. We studied the period from 1948 to 2006 and we looked at daily precipitation records from about 3,000 weather stations across the country. At each weather station we identified the largest storms that occurred and then again at each weather station we looked at trends overtime and the frequency of these storms to see if we could see if the largest storms were increasing in frequency. The upper left figure shows a distribution of

weather stations that we used across the country. On the lower right figure shows the thresholds that we used to define what an extreme storm was. Just to re-emphasize we looked at extreme weather relative to the local climate at each individual weather station that enabled us to do a comparison of areas all across the country, many of which get totally different amounts of rainfall during the course of the year. Here in North Carolina the threshold for an extreme storm in the driest part of the state was any storm that drops more than 1.9 inches of rainfall in 24 hours. Then in the wettest part of North Carolina an extreme storm was defined as any storm that dropped more than 4.1 inches of rainfall in 24 hours and then the rest of the state had thresholds that were varied in between those areas. So another way to describe the storms that we picked and to find it extreme was they were one year storms. So in a typical year between 1948 and 2006 any given location in North Carolina would expect to see one storm of this size or larger. What we found when we looked at this information that across the United States as a whole, the frequency of these extreme precipitation events have gone up by about 24 percent since 1948. We did a statistical analyses of our data to figure out the range of competence that we have in our results and according to that with 95 percent confidence we can say that the storms have increased in frequency by somewhere between 22 and 26 percent. This graph shows our results in a graphical form on the left axis is the average annual frequency of extreme rain storms and snow storms, the 's' axis is a time period. So the green dots represent across the continental United States as a whole the average annual frequency of extreme precipitation. If there were no change happening, what we would expect is to see a trend that looks a lot like this orange dashed line that goes through the middle with about one of these storms happening every year. However, the blue line represents the actual trend. In other words, what was an extreme storm back in the 1950's would not necessarily be characterized as an extreme storm today. The intensity of storms is increasing.

We also looked at this information under more local levels. In the south Atlantic area which includes states from Maryland south to Florida, we found that extreme storms had increased in frequency by about 15 percent. Here in the state of North Carolina we found that these extreme storms had increased in frequency by about 16 percent. This map shows the trends broken down at a more local level. The boundaries represent something called climate division which are boundaries that climate scientists have used since the 1950's to aggregate weather observations. As you can see in this figure some of the most dramatic increases in storm frequency occurred in the northeast where they saw about a 62 percent increase in extreme weather. In the mid Atlantic region the increases were around 41 percent; and in other areas where especially large changes occurred were in the Ohio region in Louisiana in New Mexico and in the Pacific Northwest. We determined whether the information for each one of these climate divisions was statistically significant which basically means can we say with 95 percent confidence that a change in extreme storm frequency has actually happened in these locations. What we found was that across about a little more than half of the area of the United States there was a statistically

significant increase in extreme storm frequency. In comparison there was only four percent of the United States that showed that statistically significant decline in extreme precipitation frequency so the trend is remarkably consistent across the entire country.

This is just a blown up part of that last figure looking at North Carolina and we found three climate divisions in this state that had a statistically significant increase in extreme precipitation frequency. Those are represented by the parts of North Carolina that have diagonal lines through them, so the southeastern north central and northwest parts of the state. Our results agree with what other researchers who have looked at this subject have found. In 2004 some climate scientists published a study that looked at this phenomenal worldwide and they found that storms are increasing in intensity in locations across the world from subtropical Brazil to Siberia. They have also found trends that are related including warmer weather, higher atmospheric water content, increased formation of storm clouds and increased thunderstorm activity over the United States. More over scientists at the National Climatic Data Center have concluded that most of the increase in storm intensity that we are seeing happened in the last three decades, making this a relatively recent phenomenon.

Other scientists have also looked at lengths between what's happening and human emissions of global warming pollution and they found a human finger print on a number of different trends that are occurring including increasing levels of carbon dioxide in the air, increasing global average temperature, changing temperature extremes, the widespread melting of snow and ice, raising sea level, altered wind pattern, increasing moisture content over the ocean, and increasing annual precipitation totals in temperate parts of the Northern Hemisphere. Evidence is also growing that the increased frequency of an extreme precipitation is also linked to human emissions of global warming pollution. In the last report of the Intergovernmental Panel on Climate Change they concluded that the trend that we've seen is more likely to not link to human global warming pollution and that in the future it is very likely that we will continue to see this trend increase. What are the implications to this trend in terms of the impacts that we can see here in North Carolina and in other parts of the country. Impacts can include an increased likelihood of flooding and related risk that water pollution from runoff and from sewage overflows, increased bread or water borne disease and the damage to agriculture. On the other side of that coin, we also can see an increase likelihood of drought. In the 20th century flooding was the natural disaster that caused more property damage and loss of life than any other natural disaster. I am sure that we all are familiar with serious floods that are happening in the recent times in North Carolina. For example, there was a storm in June of 2006 that struck the Atlantic coast dropping a significant amount of rain, it wasn't a hurricane but it did cause extensive flooding in communities from North Carolina up into New York. The property damage from that storm was around one billion dollars.

At the same time when you have heavy rainfall you can have increased runoff which carries the risk of water pollution. So after heavy rain water will runoff along fields or along streets and it can bring pollutants into the water making it less suitable for drinking and less able to support a diverse community of wild life. Many communities require developments to include storm water controls to prevent runoff from becoming a problem. Often times they set in thresholds say this community must be designed in order to manage the runoff from a one year storm event. However the design criteria for what a one year storm event is, if that was formulated ten or twenty years ago, it's no longer relevant because one year storms are becoming stronger and stronger over time. Communities are going to have to consider that when they are developing runoff control regulations. Other communities are going to have to revisit the controls that are already in place to take into account the fact that storms are likely to drop more rain in the future. At the same time heavy rainfall can increase the risk that the sewage system will overflow discharging raw or partially untreated sewage into the waterways which makes them less suitable for swimming or for drinking. The EPA estimates that around one trillion gallons of raw or partially treated sewage are discharged into waterways every year. This problem could become more serious because of the trend toward increasingly intense precipitation. This also carries a risk of increased spread of water borne disease. A study that looked at all of the water borne disease outbreaks that we tracked during the last half of the 20th century found that more than half of them were preceded by a major storm event.

Heavy rainfall can also cause agricultural damage, so after a heavy rain soils can become saturated which reduces the amount of oxygen in the soils and can either kill the plants out right or make them less resilient to tests. After the flooding that happened in Mississippi River Valley in 1993 there was about six to eight billion dollars of damage to the agricultural economy there and about 70 percent of that damage was due to super saturated soils as opposed to fields that were just flooded out right. A recent study by some folks at Columbia University looked at damage to the US corn crops from heavy rain storms between 1950 and 1990. They found that heavy rains caused about three billion dollars of damage each year to the US corn crop and they predicted because of the trend towards increasingly heavy rainfall damages to the US corn crop could double by 2030. At the same time the trend toward increasingly increased precipitation also brings an increased risk of drought. So as global warming progresses we will face increasingly extended periods of dry weather especially in the summer time which is expected to become drier. Then this situation will be aggregated by the fact that higher temperatures because of global warming will increase evaporation. Therefore water is more likely to evaporate out of the surface of reservoirs and out of rivers making water less available for people in North Carolina.

In conclusion global warming is already changing our weather pattern in physical ways. The climate models predict that the trend toward increasingly intense rain and snowfall will intensify in the future and at the same time the number of dry

days will likely increase making drought more likely. The severity of these trends depends on how much global warming pollution we emit. Again if you look at this figure from the latest Intergovernmental Panel on Climate Change report, it presents three different scenarios for human emissions for global warming pollution. The green line, A2 represents a scenario in which we reach about 1200 parts per millions carbon dioxide in the atmosphere by 2100. B1 (blue line) represents roughly 600 parts per million carbon dioxide in 2100 and the red line represents somewhere around 800 parts per million carbon dioxide. So as you can see the scenario that represents the greatest control of global warming pollution in this figure shows that the least increase in storm intensity. Some amount of change is inevitable given the pollution that we've already emitted to the atmosphere but the further we go in reducing emissions the more likely we are to avoid the worst impacts of this trend.

A few policy recommendations – I think we need to establish mandatory limits on global warming pollutions. Some of the things that the speaker earlier today from Maryland was talking about seem like they are on the right track. If we reach reductions of around 20 percent by 2020 and 80 percent by 2050, we will have a reasonable chance of avoiding some of the worst impacts of global warming. If we go further the benefits will increase. Also if policy makers decide to establish a cap and trade program to reduce global warming pollution emissions, 100 percent of the emission allowances or the permits to emit global warming pollution should be put up for public auction and the funds that were raised from that auction should be used for public benefit purposes including supporting an energy efficiency and renewable programs. If we do this it will help reduce the cost of meeting the global warming targets and it will make it more likely that we will succeed.

Finally, we need to adopt policies that will improve energy efficiency and increase the use of clean renewable energy. These are really important tools that we will need to deploy in order to meet the global warming targets that the science tells us is necessary. If you're interested in seeing the full report, you can find it on the Environment North Carolina website which is listed on the bottom of this flyer. And if you would like to contact me or my colleagues with Environment North Carolina please feel free to do so at any time and I'll be happy to answer any questions.

Representative Harrison: Thank you for that report. You might have said this, 1948 that's the year that you used for your research purposes and why did you chose that year?

Mr. Madsen: That was simply a decision based on the availability of data. In 1948 the federal agency that tracks weather information, that's the point in which they started to digitized a lot of their data back to 1948 and information before that would have been a little harder to get a hold of and it would have been covering less broad geography.

Mr. Garrou: Thank you very much for your presentation. Our last presentation will be from our own commission member Dr. Eggers who will talk to us about the Intergovernmental Panel on Climate Change most recent report.

Dr. Eggers: You are about to receive a forest worth of handouts I think. So if you will wait a moment I know that you're receiving several things and so one of them is the Summary for Policymakers (**Exhibit M**) of this IPCC report, another one is just a one pager that graph(**Exhibit N**), there are two documents from Southern Alliance for Clean Energy (**Exhibits O** and **P**). One of them is kind of a summary of the summary of this report and the other one is more recent scientific findings since this report came out in November. And I think possibly the final handout is Topic 6 (**Exhibit Q**) of the IPCC report which is actually just key findings and uncertainties and I think if you are going to read anything from the IPCC report that is a good place to start. It is very brief and really tells us in a nut shell what is going on.

I am going to go ahead and get started and thank everybody who, you know we separated the weak from the strong, apparently. Thanks to everybody who is still here.

The organization of this report which is not terribly long is as follows. There are six sections, the observed changes and the effects of those changes, causes of observed changes, impact projections, near and long term, and then we've got some adaptation and mitigation and then No. 6 which I mentioned that you're receiving which is robust findings and key uncertainties. Now I want you to know that the next three or four slides are boring but necessary and they will go quickly.

It is important to realize that the IPCC attaches very specific numerical values to their language and depending on what kind of approach they take to uncertainty those values are different. So under these three approaches, qualitative, more quantitative, expert judgment, statistical analyses, they have different language. Qualitatively analyzed things have very broad language like high or medium, etc. but more quantitative is as follows. So the confidences expressed as changes in ten so if you see something that says very high confidence, that means that there is a 90 percent chance or nine chances in ten. And that they had to agree that that was actually the confidence level they were dealing with, high confidence 80 percent chance, etc. Similarly expert judgment in statistical analyses, those confidence levels are, they use different words, which helps and so to say something is extremely likely means that it has greater than a 95 percent chance of happening according to the consensus of the IPCC scientists. So later in the report you will see these words used and I wanted to put these on my slides because you don't have them on any of the other handouts, they are actually in the introduction to the long report. As well the purpose of this, just to kind of reiterate what George Givens said is to actually get us familiar with this so that we can discuss the science and any questions people might have about this

specific science in more detail at the February meeting when the head of the IPCC will be addressing us at that time. So by way of introduction here we go.

No. 1 – Warming of the climate system is unequivocal as is now evident from observations of increases in global average air and ocean temperatures, wide spread melting of snow and ice and rising global average sea level. So unequivocal is a very powerful word for the scientific body to use. Some of the specific findings are that 11 of the 12 years between 1995 and 2006 are the warmest on record. We are seeing warming to a much greater extent at higher latitudes so for example, warming in the Artic is twice as high as the global average for warming. Land is warming faster than the oceans at this time and the rate of sea level rise is increasing. The sea level is rising and it is rising faster and faster and that is due both to thermal expansion and melting glaciers and ice. What kind of effects are we seeing? According to the IPCC observational evidence from all continents and most oceans showed that many natural systems are being affected by regional climate changes, particularly temperature increases. So system affects include in their report, they say there is very high confidence that terrestrial biological systems are strongly affected and you probably saw in the news for example, robins migrating farther north than ever before and indigence people not having any word in their native language or robins because they hadn't seen them earlier leaping etc. High confidence marine and fresh water biological systems are affected but medium confidence which corresponds to just over 50 percent chances for effects on human related systems, like agriculture and forestry. And that is because it takes a little bit longer for those secondary affects to show up in these systems and it is harder to measure.

What are the causes of these effects? According to the IPCC greenhouse gas emissions from human activities have increased since pre-industrial times 70 percent between 1970 and 2004 they increased. And those primarily came from three activities, the energy supply sector, the transportation sector and the industry sector. Emissions from agricultural buildings and forestry increased but at a slower rate. So graphically you can look at representation of emissions greenhouse gas concentrations from anthropogenic emissions according to this report, now when we first started meeting, Bill Schlesinger was going back two hundred thousand years in ice core data. Now the IPCC is saying quite definitively that we are seeing higher methane and carbon dioxide levels than we've seen in the past six hundred fifty thousand and that is the state of the science. And we are seeing higher nitrous dioxide than we've seen in many thousand years. The salmon in the white represent the GIGA tons of carbon equivalent per year emissions from CO_2. The salmon color is from human activities associated with fossil fuel use and other sources and then the white is from deforestation, decay and peat. We can look also at graphical representation in 2004 this was also in the report of the concentration of gases in the atmosphere and again the salmon and white corresponding to CO_2 and we've got methane and nitrous oxide, those are really kind of driving the train that so called 'F' gases are much smaller at this point and not exerting as much

climate forcing. The lower pie chart are the sectors that are responsible for emissions and when you look at that pie there are several sectors, energy supply and industry, agricultural and forestry though account for certainly the majority of it. So what are the effects of these types of emissions? The IPCC says there is very high, very high confidence that the net effective human activities since 1750 has been one of warming and that we expect for the next two decades a warming of about 1/3 ^{o}F per decade average global temperature, the net effect due to human activities since the pre-industrial era that these activities are resulting in radiative forcing of about 1.6 watts per square meter. So stay with me on this next slide, one of the more complex, this shows the relative contribution of various things in terms of the radiative forcing effect. And in this body you've heard a lot of information about conflicting theories on radiative forcing, so the IPCC most recently is saying this is what we think is the best state of the science. Everything on the right hand side of those zeros that's on the bottom is exerting a positive radiative forcing effect in other words, it's warming. Everything on the left is exerting a cooling effect, aerosol and some changes in reflectivity of the surface. So when we look at what is really driving the train, again we see carbon dioxide emissions, methane and ozone as well, stratospheric water vapor etc. Solar irradiance folks have talked about is like actually just sun spots and solar activity, this is perfectly natural. The IPCC says this is the radiative forcing solar irradiance it's not very high but the lower kind of dark red raising line is what is due to anthropogenic activity and that's about 1.6 watts per square meter as our current estimate. You may have seen this image before, kind of a way to think about this visually is as if there were 1.6 watt little Christmas light if you will, in every square meter of the surface of the planet would be one way to think about it. That was not in the IPCC report.

Climate change impacts – what's this doing? Assuming current climate change mitigation policies, this is key assuming current climate mitigation policies and related sustainable development practices, the IPCC basically said ok we need some models of how greenhouse gas emissions are going to grow over the next few decades. So there are six SERS models and you just heard about a few of them. I am going to present all six right now and show you some of what they are predicted to do. None of these six, by the way, remember this too, none of these six is reported to be more likely than any of the other six. These are just potential directions we can grow in given our current policy landscape. The A1 scenarios assume very rapid economic growth, a mid-century population peak, and rapid technology development. There are three A1 models - A1F1 is very fossil intensive that as you guess is probably going to have very high greenhouse emissions associated. A1T is non fossil intensive and A1B is balance across all sources. Then we've go three additional models, B1 same population assumption, more rapid transitional to a service and information based economy which would be less energy intensive. B2 has an intermediate population and economic growth estimate and emphasizes local solutions to sustainability, so again far less intensive in terms of energies for transportation with B2; and A2 high population growth rate, slow economic development and slow technological change, kind of a worst case that we could follow. What would these look like if

they were mapped out? And we've received this graph before on the climate commission but every time we get it, it's in black and white and then we can look at it on the screen in color and tell what things are associated with but not on the graph. So I just took the liberty of typing on the right hand side what the different scenarios are so that you can see where the lines are if you wanted to take a look at this after this meeting. You can see that A1T and B1 are graphs that are associated with lowest greenhouse gas emissions on the right hand side. And you might be thinking wait what was A1T again and what was B1? So A1T non fossil intensive, and B1 more rapid transition to service and information based economies. I'm saying this because I think this has implications for how we think about the policies we might want to put forward from this Commission and where is the bank for the bucks, what kinds of policies will be more likely to lead us on a different path. Also be aware that these are just emissions, they are not greenhouse gas concentrations in the atmosphere, so all of these scenarios would lead to continually increase in greenhouse gas concentrations because none of the emissions go below zero. They have to go net negative to actually degrease concentrations potentially, so keep that in mind.

Under the various scenarios this graph just shows you the best estimates according to the IPCC of temperature change. They are arranged by intensity so temperature change of anywhere from 3.24 ^{o}F (and I put in Fahrenheit) the report is in Celsius) so 7.2 ^{o}F. Sea level rise also on the right hand side, now these are the IPCC averages for sea level rise under these various scenarios and North Carolina would experience significantly more sea level rise because our coast is subsiding, so the numbers are much higher for us, but these are the numbers from the report.

You have one sheet of paper that has something on it that looks like this but I cut this up for the presentation, it's printed horizontally, I think, actually the lines with the red dots at the bottom. But I wanted to go through these specifically. So what you are looking at here on the slide at the top are the different scenarios and that red dot on the horizontal line indicate the best guess for warming under that scenario. You can kind of draw a line vertically from each of those scenarios to where they correspond vertically and effects on coast and health and food etc to read under A2, I guess we are going to expect to see definitely some problems with the coast, millions of people displaced etc. etc. You can look at it that way. Also on the bottom, I have a little legend here and you don't – so the dashed lines indicate that impacts continue with increasing temperatures so that more the temperature goes up the more we see that impact. The solid lines that you will see on later slides indicate the impacts are linked, so you might see one and then with more temperature increase you would see a different impact, but it is possibly linked. And the left hand side of where the text begins shows the temperature at which we start to see that impact.

Here in front of you with coasts you can see that for almost any increase in temperature we see increased damage from floods and storms and it is not until we have more than three degrees, right now we think that we receive about 30

percent of global coastal wetlands lost. Coasts are very important so let's talk about some impacts. You saw this picture today already from upstate – we are of course uniquely vulnerable in North Carolina because we have such low lying coastal plains and we are very vulnerable to storms as well. On the right hand side Hurricane Andrew the most expensive storm before Katrina in US history and then Hurricane Floyd which was certainly very, very expensive for this state, although a much lower category storm. In our coastal plains too when Hurricane Floyd sat on us and dumped all that water, there was a huge economic impact and it impacted our food system as well. With food some of the effects we expect to see are for almost any kind of warming is a complex localized effect because all kinds of different things will happen, some areas will get warmer, some colder, some dryer, some wetter. So we will see all kinds of different things happening but we will see a lot of things happening in different areas from any change in temperature. Then the rest of this focus is on serial productivity because these are just examples, these are not necessarily what the IPCC says are the most important or anything they just wanted to show some examples of warming and outcomes.

But other effects associated with food described in the IPCC report include the following: ships in areas suitable for various crops, maybe we can grow oranges here, plant diseases increasing though in many areas where it's warmer or wetter or both, plant pest increasing, animal diseases increases, and animal productivity changes. With warming we can see increased animal productivity in some places and we will see decreased animal productivity in other places, so depending on where they start, crop productivity also changing significantly.

Impacts on human health very important and also highly costly, I put this little picture of a mosquito down here because according to some scientist at the Center for Disease Control this may be one of the most expensive problems associated with global warming is the spread of areas suitable for malaria from the mosquitoes that transmit malaria. Increasing burden from malnutrition, diarrhea disease, cardio-respiratory and infectious disease for about half a degree warming will see increasing costs associated with that. Increasing morbidity and mortality from heat waves, floods, and droughts, morbidity is just how many people get sick, mortality is of course how many people die from something so for almost any increase in temperature we will see increases in those. In changes in distribution of some disease vectors, so definitely in the report says there is a likely increase in heat waves. I'll show you about disease vectors a little bit, we'll return to that in just a minute but first water which may really be the story of the 21st century. So the report for almost any increase in temperature again increased water availability in the moist tropics and high latitudes there is not decreasing water availability and increasing drought in mid latitudes and semi-arid low latitudes. They also predict hundreds of millions of people exposed to increasing water stress to cause civil unrest. In North Carolina we're already exposed to water stress, this is the US Drought Monitor, so I got this from January 8, 2008 and you can see that the darkest color that it looks to me is about half of the area of the state is what is called exceptional

drought and the red is extreme and then the remainder which is mostly orange is just severe. So that is where we are right now.

Stream flows, this is from Monday, January 14th, just two days ago, this is stream flows in North Carolina and you can see and it is no surprise that stream flows are very significantly low as well and I don't know about the rest of the state but there is a lot of talk about hay in western North Carolina and where are the people are going to get the hay over winter for their animals and hopefully a lot of folks have gotten that straightened out. So the report says there is a likely increase in areas affected by drought and a likely increase in heavy precipitation events, this is actually in Asheville, the ruminants of Hurricane Frances which came through and left 13 to 17 inches of rainfall on us in one day so the entrance to the Biltmore Estate and just (inaudible) system of the area that flooded met down there, very expensive for our community. Other outcomes the IPCC report says a very high confidence the systems related to snow, ice, frozen ground are affected and high confidence in increased runoff earlier spring melting which has a major implications for snow and glacier fed rivers and lakes, also warming of lakes. This is an actual river bed out in Washington State, early spring melting this year resulted in that river bed being virtually dry at this time. On the left hand side in the lower part of the screen, this is a salmon spawning stream. During the period when salmon would be spawning in it but it's a high stress spawning environment, very high stress spawning environment, it is completely dry, as well has a logic effect, increased runoff which you already saw so increased pollution loading, sedimentation, negative impacts on fisheries, negative impacts on coastal water quality and inter-coastal especially. The lower left hand corner, that is a reservoir that is used for hydropower generation and it's not doing a lot of hydropower generation in this picture because of course, it is very dry and up above that's a coal fired power plant, another problem that we're expecting to see is lots of cooling supplies for coal and nuclear power plants. So that is very important as we think about our energy future, we've had plants shut down in Tennessee and in France this year because of lots of cooling supplies, water cooling supplies, so that's a higher risk endeavor than we ever thought before at this point.

Impacts on ecosystems finally, increasing extinctions up to 30 percent, increasing coral bleaching, lower right hand you can see health corals and bleached corals. If we warm up a few degrees the IPCC says the terrestrial biosphere will turn into a net carbon source to warming over two degrees, turn into a net carbon source and really start positive feedback would force that pretty quickly. Species ranges also changing significantly, increasing wildfires etc, so this is a picture of our lovely mountains in western North Carolina we are predicting a lot more increasing wildfire impacts that expire in eastern Washington State, the tripod fire. There is a very likely decrease in cold days and nights predicted and frankly we all joke that whew global warming, bring it on you know especially on a day like today but remember with all those cold days and nights we have so much increase in disease vector for humans the ticks in the lower right hand corner and I could have filled up the page but that's kind of

gross for most people. But on the upper left hand corner you see wood boring insects and so major impacts potentially for forestry in North Carolina as we warm up and don't have as much bug die back, so things to think about.

In the report they talked about mitigation and adaptation at pretty great length, sections 4 and 5 are all about that. It is not a long report, I would recommend that you read it, but the report says more adaptation is required to reduce our vulnerability to climate change and a wide range of options exist now and are expected to exist under current technology trends by 2030 that for all sectors and the cost of mitigating CO_2 is averaged in the report and we know these are very big guesses economically. But $12 per ton of CO_2 for offsetting emissions or sequestration or what have you, the range in the report is negative $9 to $100 per ton with an average of 12.

So in a nutshell, I think this is the take home, the report says climate change is happening we're almost positive as positive as scientists ever get, humans are the primary cause, it will result in extensive and possibly catastrophic negative effects if no action is taken. And it is possible to significantly reduce the impacts on humans and non human systems and that the key actions required to reduce impacts are in the following areas. 1) To reduce fossil fuel consumption by expanding alternative energy, increasing generation and distribution efficiency, and low carbon energy sources and it does say nuclear in the IPCC report as part of that. To increase efficiency of cars, buildings, and industry are important. Reducing agriculture and waste emissions and increasing sequestration and finally adaptation and there is a (inaudible) on coastal adaptation in there as well. So all of these things will be required to reduce impacts on the human population and with that I'll just say do you have any questions?

(?): The terrestrial biosphere will tend toward a being a net carbon source at two degrees. Why is that?

Dr. Eggers: Increasing decomposition primarily, increasing rates of decompositions.

Dr. Riggs: Thank you for being so depressing here. How do we go forward, we're in our second year in this Climate Commission, this is an overwhelming undertaking, we heard the previous speaker talk a little bit about the economic cost to North Carolina if we do nothing in our coastal area and I would say from my experience that was incredibly conservative. But you've itemized another dozen, two dozen, three dozen issues here all of which will have an economic cost if we do nothing. This has been a very valuable experience sitting here learning about all of this, but I think it's time to get moving. I don't know how you get a Commission like this moving or I guess we've got some motion in the energy aspect of this but an awful lot of what you've mentioned hasn't even been on the table and I would like to make some kind of a motion that this Climate Commission burns some fuel and get some action going. We are all getting

older and things are changing and they are not going to wait for us. Thank you for your presentation.

Dr. Eggers: Thank you, I've heard this IPCC report called the We are All Going to Die Report and we are all going to die but let's not go down the tubes in such an unaware way as this. I think the most dangerous thing is business as usual and there is tremendous pressure for business as usual and it would be very nice if the room were entirely full for this and the last two presentations.

Mr. Garrou: Just to respond to you Dr. Riggs, we intend to start bringing forth some recommendations in March so I agree with you, we need to move.

Dr. Smith: In that spirit and building on the excellent presentations and then some of the things we heard earlier particularly the first thing that we heard about activities in Maryland earlier this morning, I don't whether these reference to whether we are the weak or the strong but those of us who are left here this late in the afternoon. I don't want to attempt to have the Commission decide anything at this moment but I do want to queue something up. It seems to me that based on the science we've heard over the course, the report this afternoon on the IPCC, the fact that we'll have distinguished guest at the Emerging Issues Forum coming up, gives us a fairly clear sense of what is a scientific goal for reductions going forward. We have also had discussions within this group about the various aggregate of policy activities that we can undertake and potential outcomes and North Carolina has taken some action over the past year. The Legislature with renewable standard and some other important provisions and those could be aggregated together to identify a suite of things that could give us a target. Where I am going is that as we discuss the concepts of a goal for reduction for the state, I think there is a goal that is based and grounded in science and as we heard from the Maryland example, may be aspirational and then there is a goal that I think it is very much within our grasp and then there is probably some gap between the two. And I guess what I wanted to queue up and I don't know if we can have a little discussion about it today, but for sure getting this in a more frank discussion going forward is, is it reasonable for us to think about having two goals one aspirational based in science and one directional based in an aggregate of policy recommendations that are achievable and can we set forth process to more fully debate that within the Commission. Because I think that is an important outcome of this stage of our work and I think it also gives us some directional targets that the fact that Dr. Riggs point so we can have some sort of benchmarks that we're accomplishing some things because there are some solid metrics being met and we have some benchmarks along the way that we can shoot for and this may then advise us going into the legislative session about what is possible. Again not seeking a formal decision at this point but wanted to queue that up and maybe think a little bit about how as a Commission we can go forward to address these opportunities.

Mr. Toben: I think this (inaudible) goal and I agree that that a discussion that could be had perhaps the March session given the agenda for February. But one

area that might be a rich vein to mind is to look at these other states that are undertaken a full study of mitigation options. Florida, California, New Jersey, New York some of the RGGI states already have enacted a number of the pieces of legislations that we are considering at least topically. I do think that those could be guides for us to look at, the CAPAG process has been a very useful process in terms of identifying large numbers of potential areas for us to explore in terms of draft legislation but it's a long distance between those recommendations and draft bills that might be considered in this upcoming session and even the 2009 session. I would encourage those of us that have particular areas of interest to really explore the other states' legislation related to those topics of interest and to bring those forward and as discussion points potentially in March or in the interim submit them to Mr. Givens for consideration and have the top seven or eight of those considered by the Commission and then discussed in the context of the sort of aggregate group and then also have the more aspirational goal as an agenda item for March.

Representative Harrison: Thank you for that presentation. I tried to get through the report and I didn't understand it nearly as well as your presentation today. I don't think I really got the context of the net radiative forcing the 1.6 watts per meter square. What's the context there if there weren't any anthropogenic impacts on global warming would be at zero or is there some naturals that can be said to solar but in terms of how we should look at 1.6 watts per meter square?

Dr. Eggers: I think from the scientific standpoint basically what that says is that as of now human activity are responsible for increasing the amount of energy on this planet and the amount we have increased it by is 1.6 watts per meter square. So it is kind of a definitive statement that human activities has increased the temperature of the planet and if we don't go off from business as usual we will continue to increase it just because of increase of greenhouse gas condensation in the atmosphere. Does that answer it?

Representative Harrison: Kind of but if we were attempting to mitigate it where would we be or if we didn't have any impact would it be at zero or 0.5 watts per meter square?

Dr. Eggers: Depends on the time scale of the analysis but basically it does depend on the science period so if we had prefect data over the entire history of the earth it would be at zero. And with that solar radius it shows that solar activity has warmed us up a little bit recently increasing solar activity but if we had the average over the history of the years it would average down to zero and the fact that there were no humans and no houses it would be zero. There would be things that would be making it cooler in certain periods of time and warmer doing certain periods of time if we just analyzed that year and that decade but over time it would be zero because it would be the average for all of those things over that time period.

Dr. Riggs: Just to add comment to that is a way to think about this is that there is a lot of stored solar energy buried in the earth that we're burning as fossil fuels and it is bringing more energy into the active system that's been stored there for hundreds of millions of years than would happen normally. This is your fossil fuel connection. Fossil fuel is stored solar energy and it has taken four hundred million years to produce our oil, we've burned it in a century.

Ms. Preyer: Thank you very much for breaking down something that is this important and was pretty formidable to most of us so I really appreciate that and based on you have experience coming as a scientist, knowing a lot about this report, you are also a commissioner and you hear the kind of concerns we are talking about of where we move forward and ideas. What would you recommend when we have this opportunity in February that we would ask the head of IPCC about and how can we take advantage of that time that would help move this commission?

Dr. Eggers: What would be optimal is that every single Commissioner be there and agreed that this is the best state of the science and we can move forward. The questions for Dr. Pachuari I think one of the most important questions for him would be: What do we know now that we didn't know in November? The answer is almost always the same. Well everything is going faster than we thought it was but here what we know now that we didn't know for the November report. Also what he thinks we need to do and personally I believe we need to go carbon negative. Eighty percent etc. etc. sounds (inaudible) but the outcome if we don't do or even if we do it is pretty bad and I think we really need to focus on sequestration. Now that is going to be a hard sell but that's the order. The sequestration is a big part of the solution and there was some proposed legislation you all got copies of today with regard to increasing soils and participating in carbon market and forestry and things like that. Great stuff to do. We can learn from other states but other states went through processes last year, two years ago when the science was not nearly as definitive as it is now. So if we follow the lead of several other states we will actually be behind the science at this point. So we probably need to also be looking at going much further in our emission reductions goal. In looking at this as a possibility Tim and I were talking about this on the side this time and last time, it would be great for North Carolina to put forward a green collar jobs initiative to really ramp up economic growth and ramp up training in the sectors where we need people trained. We need people trained who can go in and put in solar hot water systems, properly size them, properly install them, we need people who can go in and actually properly insulate homes. We need people trained to properly inspect buildings and we need to enforce our building inspection codes for new buildings. There are a lot of times new builders have spoken to inspectors who say the penetrations of the exterior wall where water and things come in and out are almost never properly sealed and air is just flying in and out so the code might be ok but the performance is terrible. So we fortunately because we haven't done much we've got tremendous opportunity. But for the state we can do a lot of job creation and we also need our community colleges and universities

to be doing different kinds of training with students so that when our engineering students graduate, when our architects graduate and even when our accountants graduate, they understand the relevance of these things and how to think about them and how to be trained actually contribute to an economic shift for the state. Otherwise, we are just talking about driving off a cliff at 5 mph.

Mr. Garrou: Thank you Dr. Eggers that was a great presentation, very helpful. Now back to the more generalized discussion.

Mr. Stephenson: Thank you Mr. Chairman, we saw several presentations on adaptation today and I think it is pretty clear that the changes that we will be facing in this state are significant from both an economic and ecological prospective. One of the recommendations that the Commission approved back in the spring of last year was to consider developing a blue ribbon commission or committee on adaptation to look at the various aspects of it both the coast and all the state. Now that the commission appears to be continuing in 2009 I think the question is how do we approach that recommendation, how do we deal with the issue of adaptation? It could be that a CAPAG process on adaptation may be appropriate to advise and provide recommendations to the commission but I just like to not lose that as we go into March and suggest that we revisit that recommendation and find a way to take action.

Ms. Tompkins: Thank you and thank you for your great clarifying presentation. I would like to ask how could something like a green collar job initiative or manifest be done in relation to this Commission? I think that it is time that we as the Paul Reveres of climate change for this state get some information out to the citizens of North Carolina, maybe doing that initiative would be one way to do that. I think the citizens of the state would like to see some time line especially if we've got another year to be working on this. So that really is a question to the chairs about how we might do that and we could continue this with emails, but maybe a brief answer now? Thank you.

Mr. Garrou: On the green education thing, there may be things that we recommend that will not require legislation. I can't think of what they are. I think most or all of our recommendations will involve recommendations to the Legislature. So we will be drafting legislation that we will present to the Legislature and ask them to pass and that will be included.

Ms. Tompkins: Could something like a green jobs state wide manifest, whatever you want to call it.

Mr. Garrou: If it is going to take money, then the General Assembly will have to appropriate it and we will have to go through the General Assembly.

Ms. Tompkins: If any of the commissioners have any creative ideas on that I would appreciate them.

Mr. Garrou: I agree with you about it is time for us to begin to educate the public about what we are going to be recommending.

Dr. Eggers: In what way would the Commission engage in education? Would this body put together a one page state of the science or state of the commission opinion and do that as a press release or how would that work?

Mr. Garrou: My thought and this is just my own thought is in connection with whatever recommendations we make of the Legislature we would want to justify those recommendations and we would want to justify them to a wider audience than simply the General Assembly. That is my own thought.

Mr. Urlaub: Thank you. Along the lines of this discussion that I know has been buzzing for a while now about green collar jobs, we've had a lot of debate in our nonprofit organization about the value of focusing on job training up front. You can train a lot of people to do something but if you still have a regulatory in policy environment that precludes companies from employing people that do those things, they are not going to find jobs at least not here. We have Appalachian State University's appropriate technology program where a lot of those students are leaving our state to go work in other states because the opportunities are not nearly as competitive here in our state. That continues to be a red flag for our organization as we access the priority order here of what we can do to go about in a simple fashion of creating a green economy for our state. We are seeing indicators that we may very well have very fundamental barriers distracting or not attracting industry here and not motivating existing industry to transition into for example the new energy economy and green jobs sectors. An evaluation of that or at least a discussion of that, like what are those remaining barriers, I know that is a really tough, it's a conflict laden and often politicized discussion and I would just hate to see us kind of opt for the easier take incentive options to spend money on a training program option without that precursor discussion.

Mr. Garrou: Good point thank you. This has been a long session but I think it has been a good one and appreciate everybody here coming and we look forward to seeing you at the Emerging Issues Forum. Thank you very much. We are adjourned.

Respectfully submitted,

Mr. John Garrou, Co-Chair	Thelma T. Utley
Co-Chair	Commission Clerk

APPENDIX

Exhibit A	Visitor Registration Sheet
Exhibit B	Emerging Issues Forum Invitation and Website Information
Exhibit C	Agenda
Exhibit D	Photocopy of NC State Alumni Magazine Cover and Information on Dr. Rajendra K. Pachauri
Exhibit E	A Legislative Proposal to Prepare North Carolina's Agriculture and Forestry Sectors for Emerging Carbon Marketplace
Exhibit F	Maryland's Climate Action Plan Establishing Goals by Tad Aburn
Exhibit G	Press Releases – N. C. Energy Policy Model 'Not Credible' and Serious Problems 'Plague' NC Climate Change Report – Senator Pittenger
Exhibit H	Background for a Process on Adaptation to Climate Change in North Carolina – Climate Action Plan Advisory Group
Exhibit I	Impacts of Global Warming on North Carolina's Coastal Economy (2) – Chris Dumas
Exhibit J	Planned Work Products: "North Carolina Coastal Hazards-Economic Implications of Severe Storms and Sea-Level Rise" – Steve Culver
Exhibit K	Environmental Defense News Release and Florida and Climate Change – The Costs of Inaction – Dr. Frank Ackerman
Exhibit L	When It Rains, It Pours – Travis Madsen
Exhibit M	Intergovernmental Panel on Climate Change Fourth Assessment Report – Dr. Eggers
Exhibit N	Examples of Impacts Associated With Global Average Temperature Change – Dr. Eggers
Exhibit O	IPCC Fourth Assessment Report: Summary and Key Findings – Dr. Eggers
Exhibit P	Southern Alliance for Clean Energy – Dr. Eggers
Exhibit Q	Topic 6 – Robust Findings, Key Uncertainties – Dr. Eggers