Asheville AMS
Minutes of Meeting
22 Mar 2007

1. The sixth meeting for the 2006-07 season of the American Meteorological Society (AMS), Asheville chapter was held on Thursday, 22 March 2007 in the Folk Art Center on the Blue Ridge Parkway near Asheville, North Carolina. It was called to order by the chapter president, Maj Paul Roelle. There were approximately 130 persons in attendance.

2. The Asheville AMS chapter presented the monthly "Healthy Environmental Award" to the organization promoting healthy environmental programs. The March award was presented to Mr Rick Icenhower, the president of Water Solutions, for his effort in preserving precious water resources. Mr Icenhower explained his company is working with businesses to capture rainwater for use in non-potable water uses. Cisterns, used frequently in the past, are again being emphasized to collect water. The company is also working with filtration and sterilization systems to make non-potable water safe for drinking. He was presented with the local chapter certificate.

3. The local Asheville AMS chapter continued it series focusing on climate change. This was the second of three talks in the series. This month's speaker was Dr David Anderson, NOAA's National Climatic Data Center, stationed in Boulder, Colorado, who was introduced by Mr David Urbanski, the AMS local chapter vice-president.

4. Dr Anderson's talk asked the following question; "Abrupt climat change – what do I need to worry about?" The talk was based on the latest information given in briefings to the White House, Department of Commerce, and the Office of Science and Technology Policy. This information was gleaned from dozens of scientists around the world.

Figure 1. Dr David Anderson presents his talk to the Asheville AMS on abrupt climate change.

Figure 2.

6. During the last few years the topic of global warming has been receiving increased public and policy maker attention, partially illustrated in figure 2. The increased interest is fueling more public participation in learning about global warming and pressuring policymakers to pay attention to the issue.

7. There are several scientific methods to “reach back” in the earth’s climatic history. One such method uses ice cores from the Antarctic ice shelf. A chemical analysis reveals changes in the atmospheric composition from which, by inference, global temperature records can generally be reconstructed for the last several thousands of years. Other methods are also illustrated below.

Where do we get this stuff?

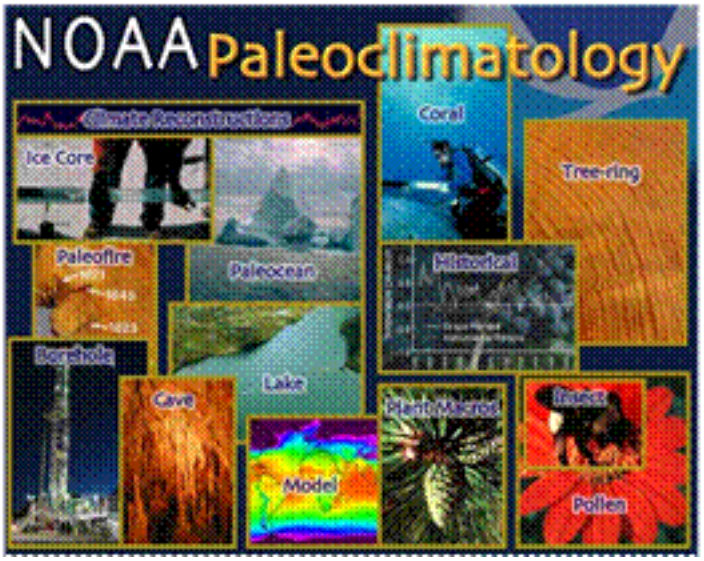

Figure 3. Ice core samples and other sources of reconstructing past climate history.

8. Looking into the less distant past, global temperature records have been graphed. Figure 2 shows the temperature anomalies, in ºC, for each year since 1880, with 1940 considered the base year. Coincident with the temperature bars is a line graph indicating corresponding CO_2 concentrations in parts per million (ppm). Not only does the graph indicate a general trend toward warmer temperatures, but a corresponding higher trend in CO_2 concentrations. Dr Anderson equated the causal effect of rising CO_2 atmospheric concentrations to the resultant increase in average global temperatures

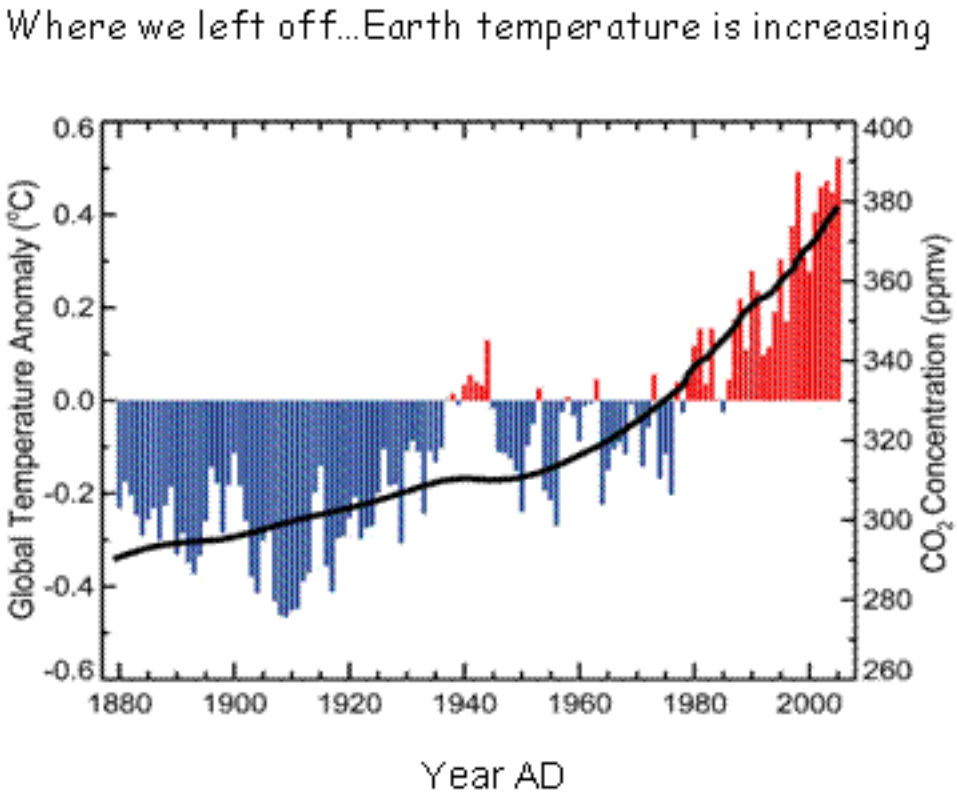

Figure 4. Comparison of average global temperatures and CO_2 concentrations.

9. Dr Anderson then posed the question, “Will climate change produce significant problems to plant and animal life on earth?” Plotting computer generated temperature forecasts, based on differing input variables, indicates ranges between a slow, steady increase to a continuing accelerated temperature rise. A more dramatic forecast increase shows a 7ºC rise in temperatures by the end of the current century.

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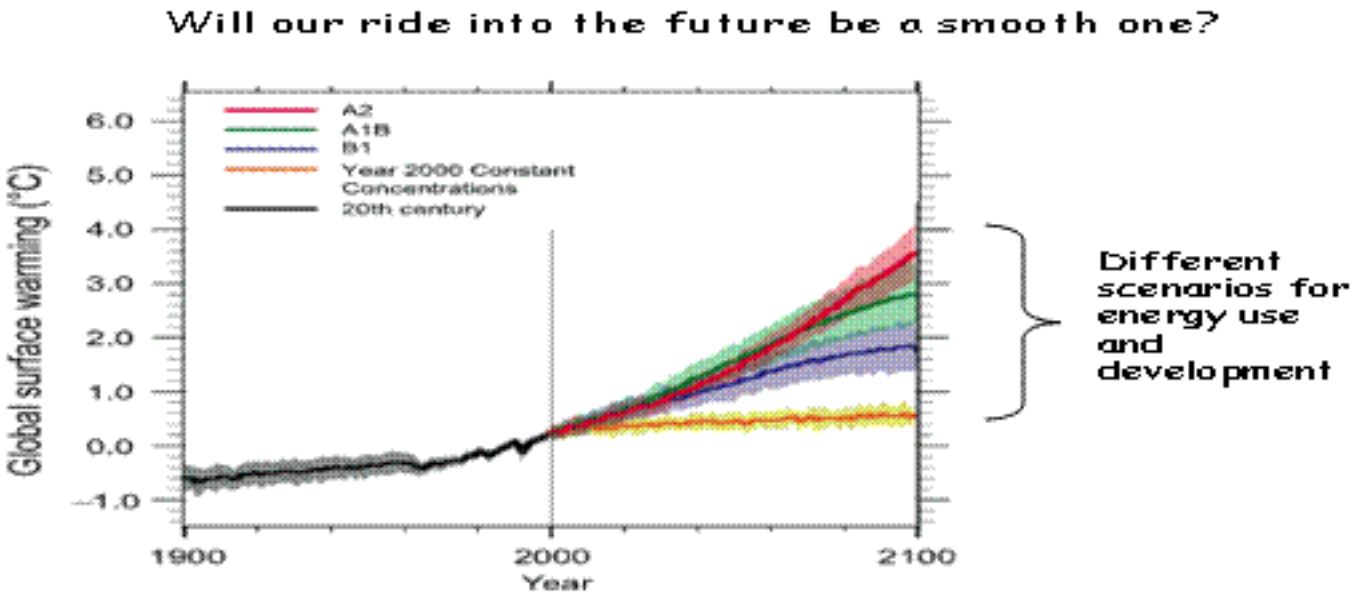


Figure 5. A comparison plot of various forecast temperature profiles out to 2100 AD.

10. An example of a past climatic change that resulted in human migration was given. Ice cores from Greenland indicate it cooled 3ºC, followed by a migration of Viking settlements out of the area. Greenland has seen abrupt climate changes before that time. Approximately 15 thousand years ago there was dramatic warming in Greenland, followed by more dramatic, abrupt cooling a couple of thousand years later, then a rapid rise again around 10 thousand years ago to near current levels.

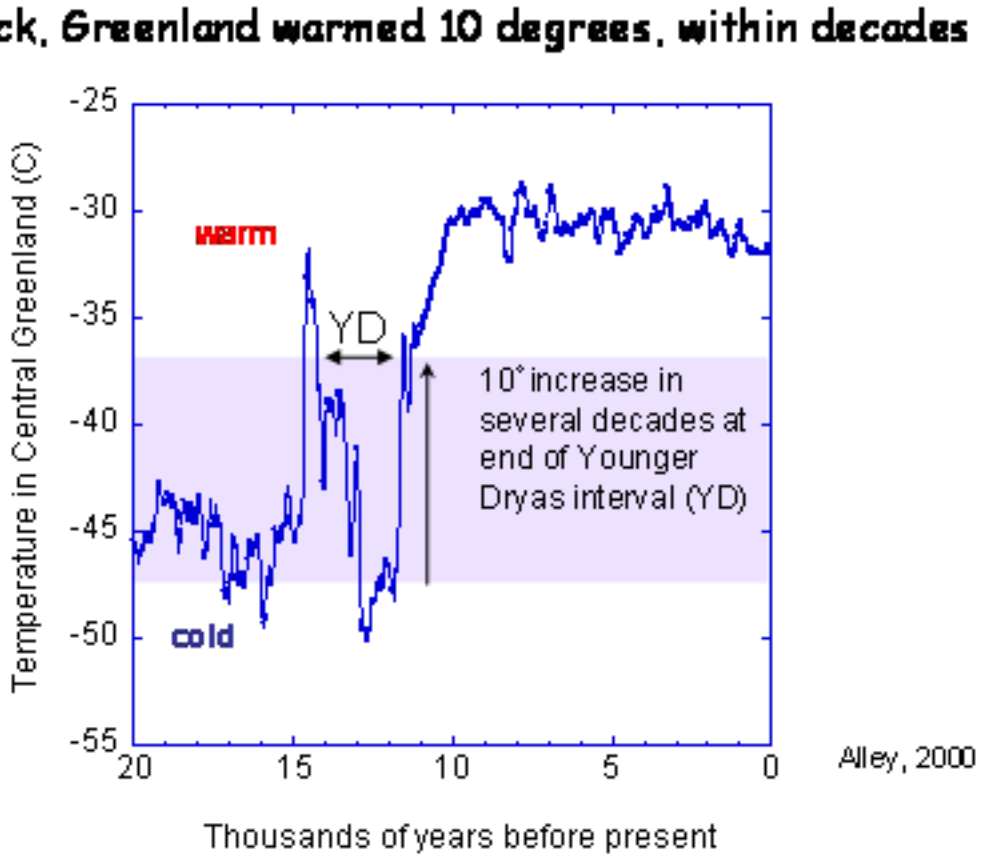
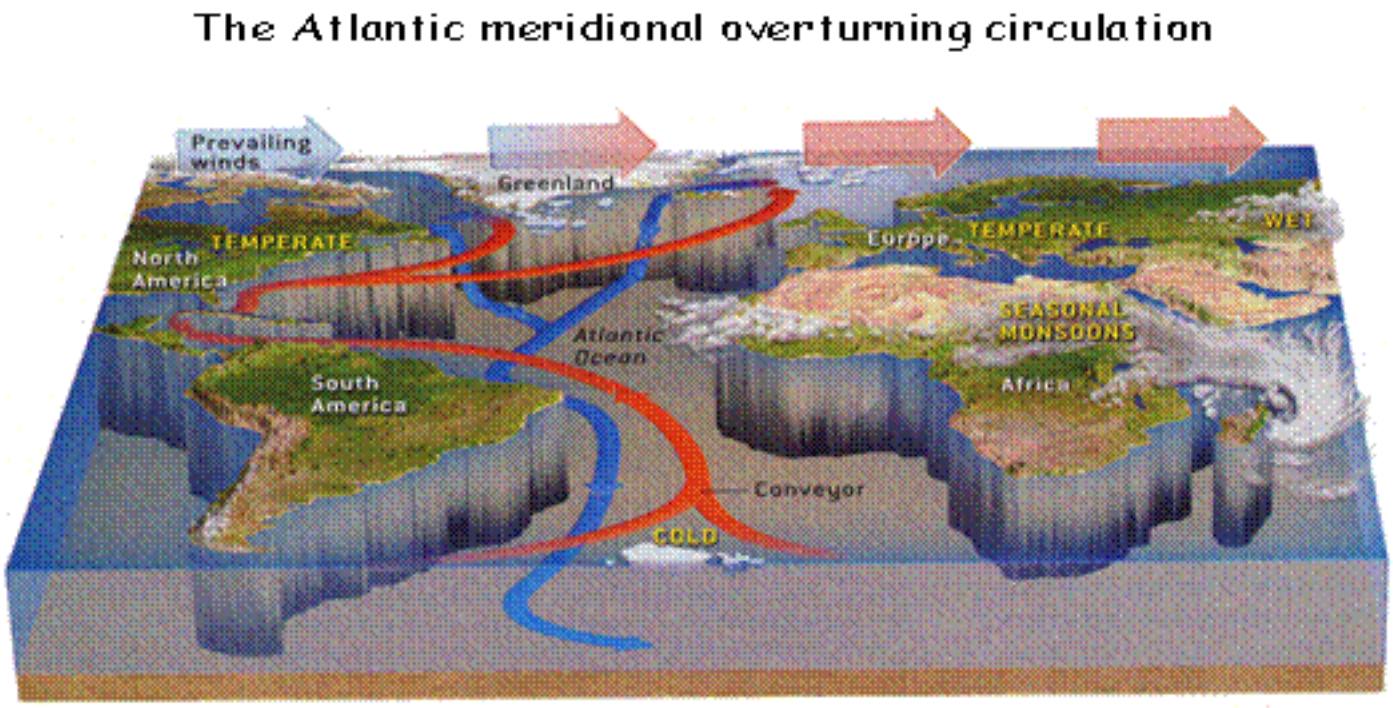


Figure 6.

11. Dr Anderson explained there are two methods by which to define climate change. One, the "mechanistic definition" states change is the transition of climate system on a time scale that is faster than the cause. This can encompass up to several centuries of change. Examples of this include the Atlantic Ocean "overturning", rapid ice sheet melts and resultant sea level rises, and release of methane from the Arctic permafrost. The other, "impacts based" states the change of the climate system that is faster than the adaptation time of social and/or ecosystems. This can happen is decades. Examples include the rapid decrease in polar bears due to loss of ice flow habitat, an explosion of pine beetles due to less extreme cold temperatures which kill the larvae, and changes in cold regions transportation which depend on frozen ground and rivers part of the year. This will be further discussed later in these minutes.

12. One of the above effects that is being looked at closely is Atlantic meridional overturning circulation. Currently much of the tropical heat is carried northward in our hemisphere (northern and western) by the Atlantic surface currents. It is gradually released to the air as it moves northward, warming certain land masses more than would be expected based on latitude. This is especially noteworthy in Europe. As the surface water layers cool they become denser and gradually sink in the north Atlantic, to return southward as a sub-surface current and rising in the south Atlantic regions to absorb more heat from the atmosphere as is passes northward through

the equatorial regions. This is illustrated in the following figures.



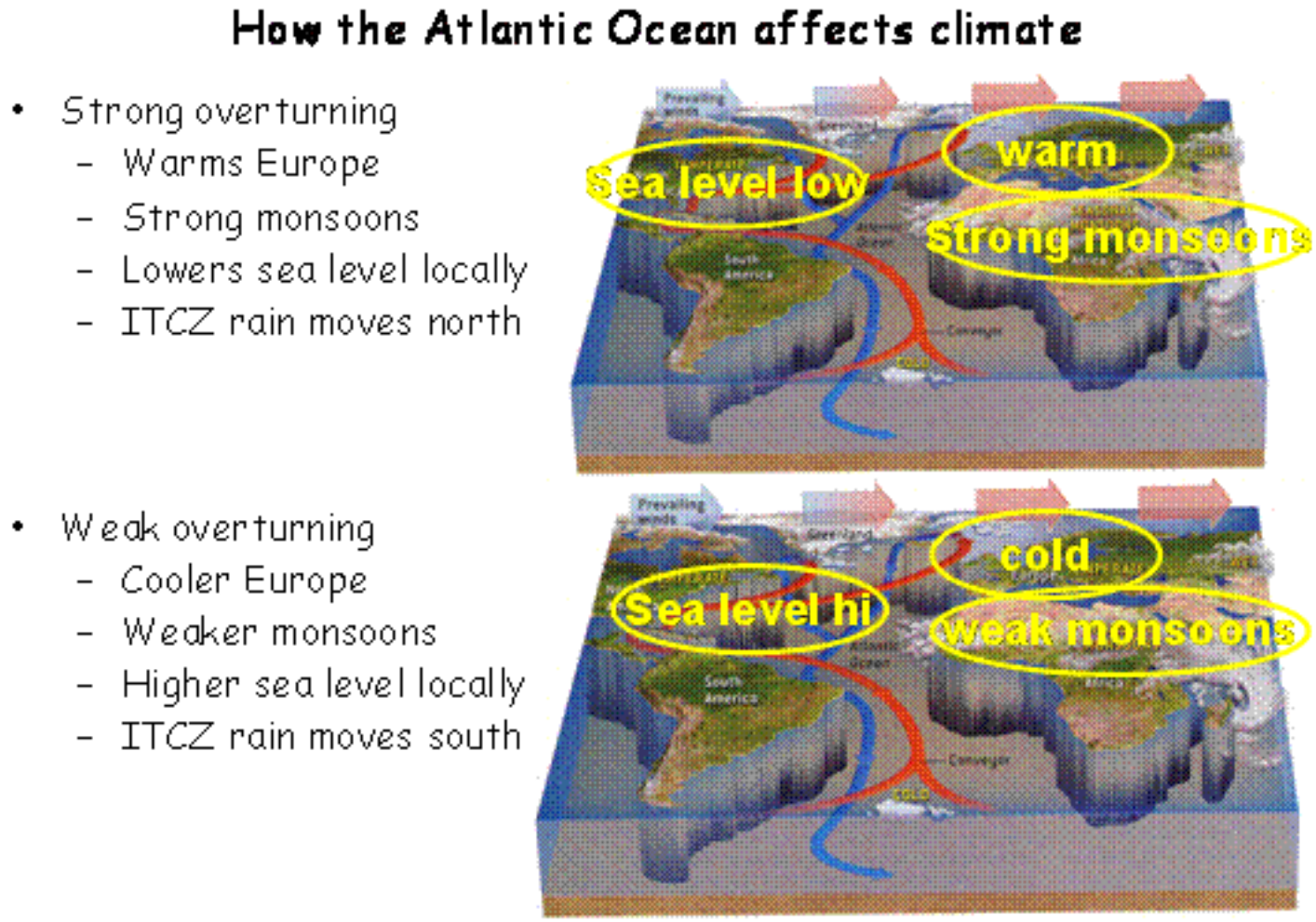


Figure 7. Atlantic meriodional overturning.

13. Changes in the Atlantic meridional overturning would have significant impacts to the Earth's climate over large areas. Increases in temperature also enhance the precipitation in some areas. In the north Atlantic this would increase the fresh water on the surface, less dense than the saline rich waters there currently, and thus less prone to sink at current rates and as far north. The same temperature increase will hasten glacier and ice melt over Greenland and the Arctic areas. This adds to the less dense, fresher water of the north Atlantic, exacerbating the decrease in meridional overturning. What are the predictions concerning north Atlantic overturning? The following figure illustrates four predictions, based on various assumptions. All show a decreased overturning.

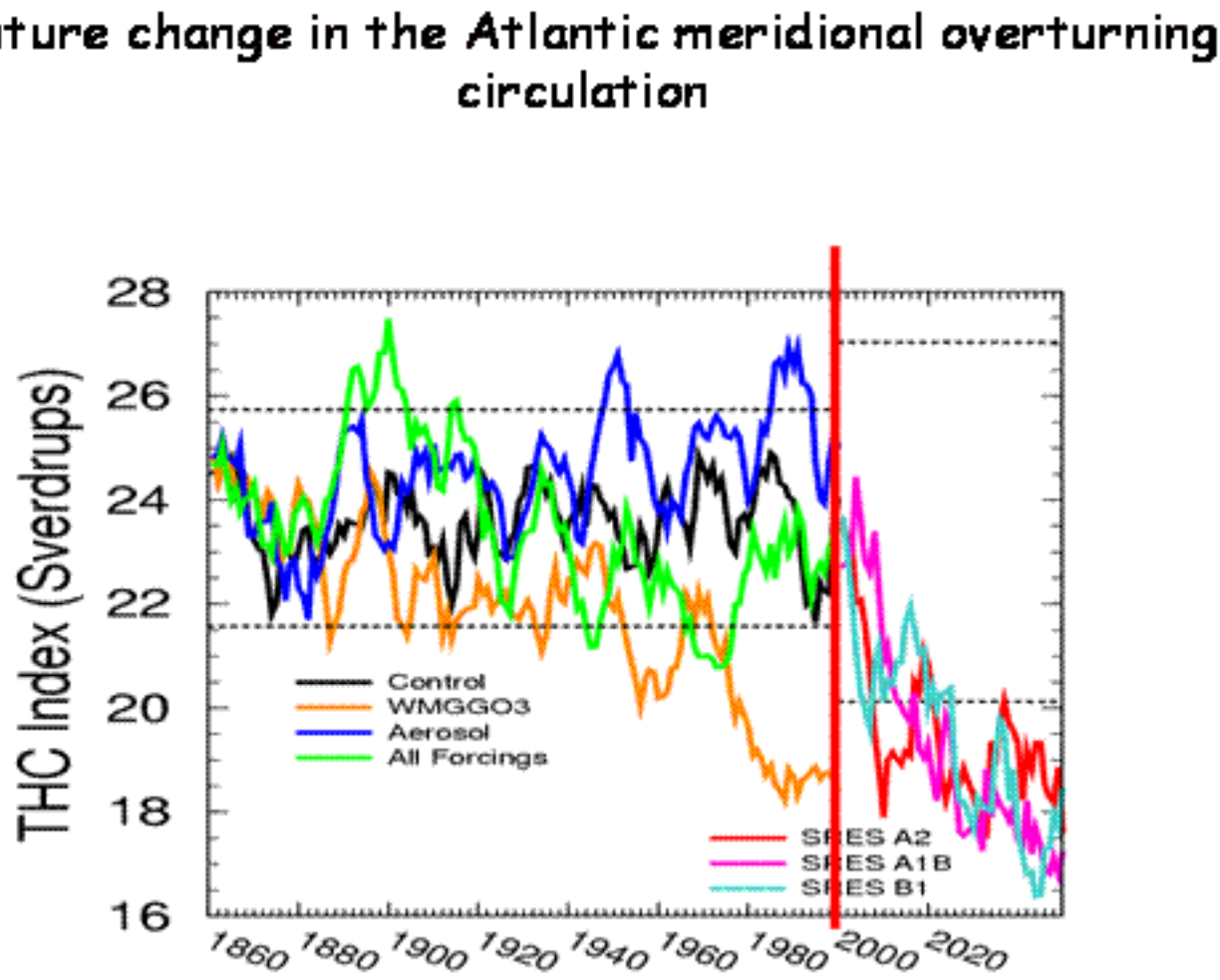


Figure 8. Past observations and prediction of north Atlantic overturning. The lower the number the less water volume involved in the overturning circulation.

14. Is this a real threat? We can observe the ice melt over the northern areas. Satellite-based observations of summer ice melt over Greenland are illustrated in figure 9. This is further stratified by area and volume in figure 10. Figure 10 is based on radar satellite pictures, with the darker red showing the increase in ice melt in 2005. Increasing ice and glacial melt is real. This fresh water is pouring into the north Atlantic. Adding to the increased flow of melted ice and ice flow into the north Atlantic is a mechanical process not considered in most computer models. As ice melts some of the water percolates down through the ice to the underlying bedrock. This lubricates the ice sheet and ground interface and hastens the effect of gravitational pull down from the land mass into the ocean. Because this is not considered, but is an increasing real physical process, the predicted rise in sea levels may be under stated.

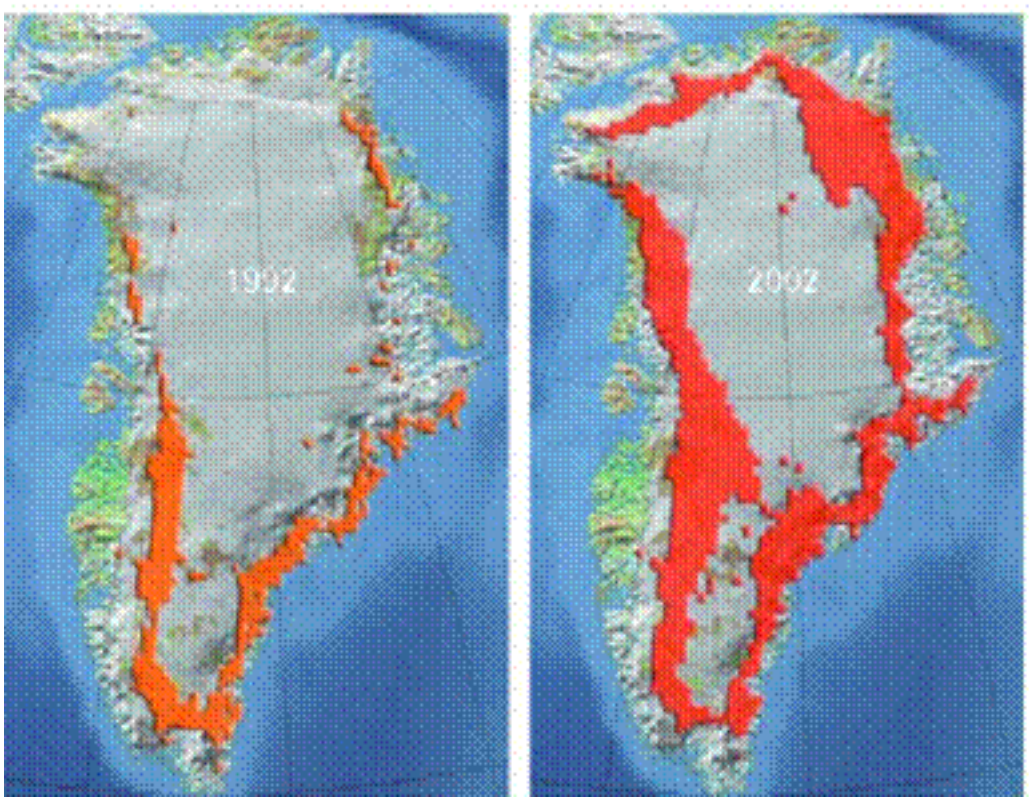

Satellite-based observations of summer ice melt
1992
2002
Red shows seasonal surface melt extent (slush and ponds of meltwater) for two extreme years. Surface melt has increased 16% between 1979 and 2002.

Figure 9.

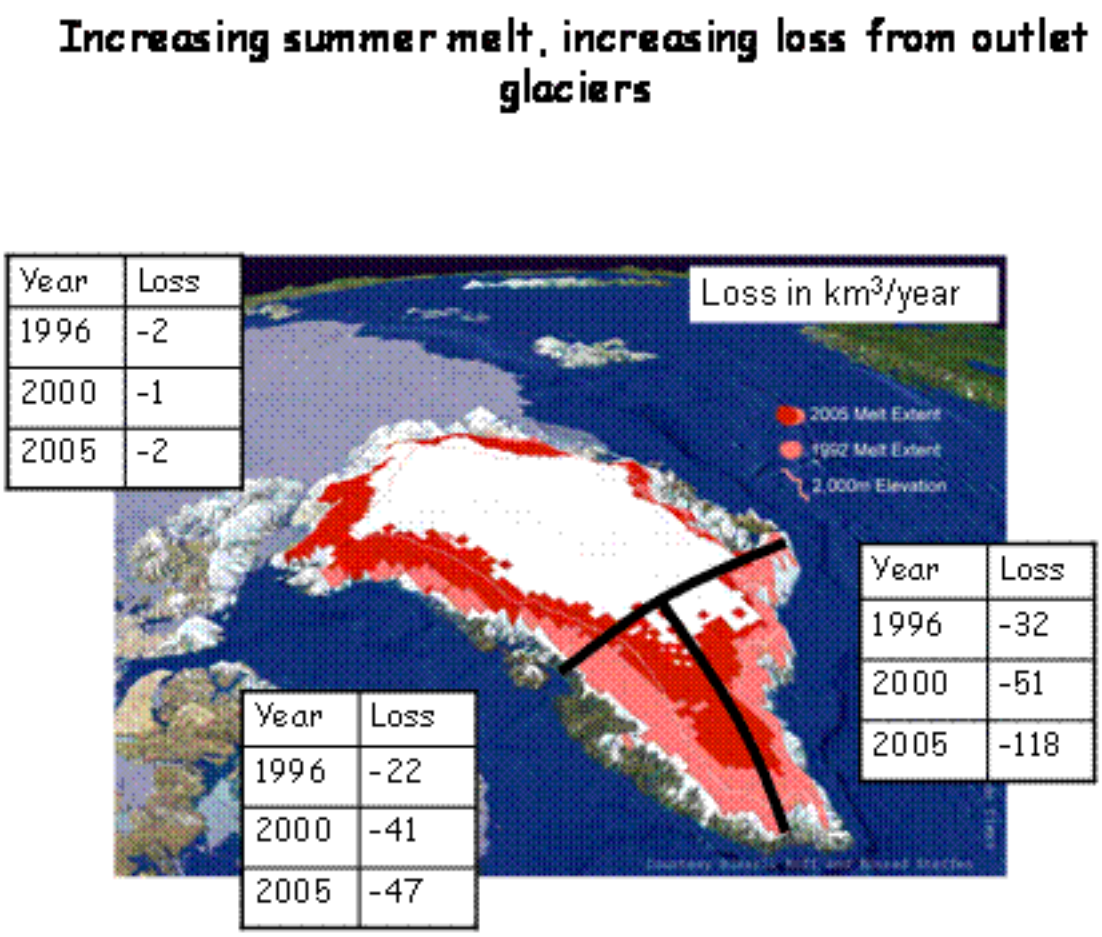


Figure 10. Greenland ice melt partitioned by 3 areas over the landmass.

15. Using the prediction of rise in sea levels of 6 meters, or 6 ½ feet, based on ice/glacial melt the following figure shows the extent of coastal inundation that would result in the southeastern United States. Compounding the extreme problems resulting from coastal inundation would be an enhanced leaching of salt water into the current fresh water tables under the land that still remains dry but within a certain distance of the new coastline. Several large cities and huge populations would be affected.

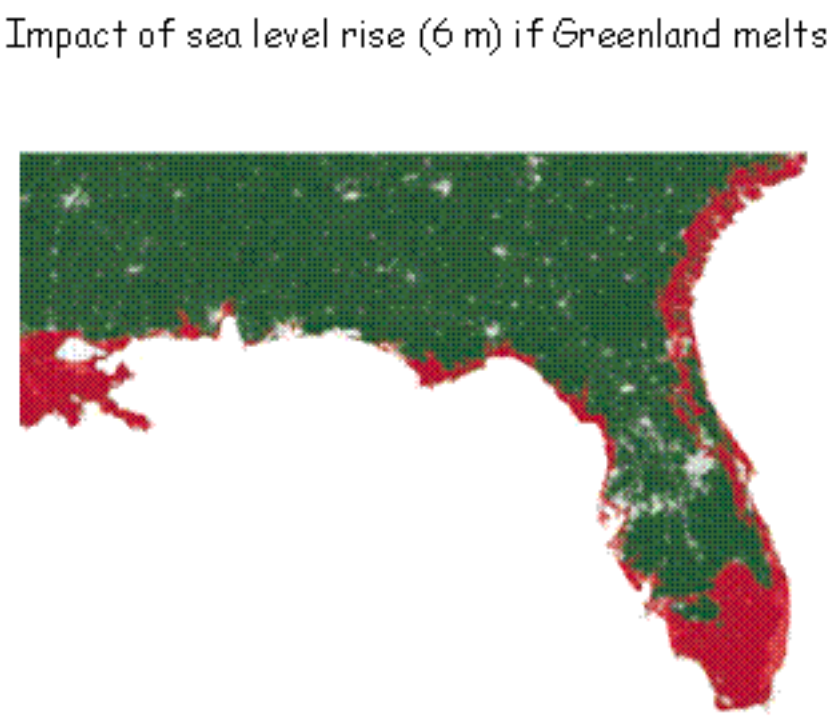


Figure 11. Coastal inundation, in red, for the southeastern U.S with a 6 meter sea level rise.

16. There is also another consequence of rising surface temperatures that could also have serious consequences, but is sometimes overlooked. The following illustration shows the areas of the northern polar regions that contain frozen arctic soil, permafrost.

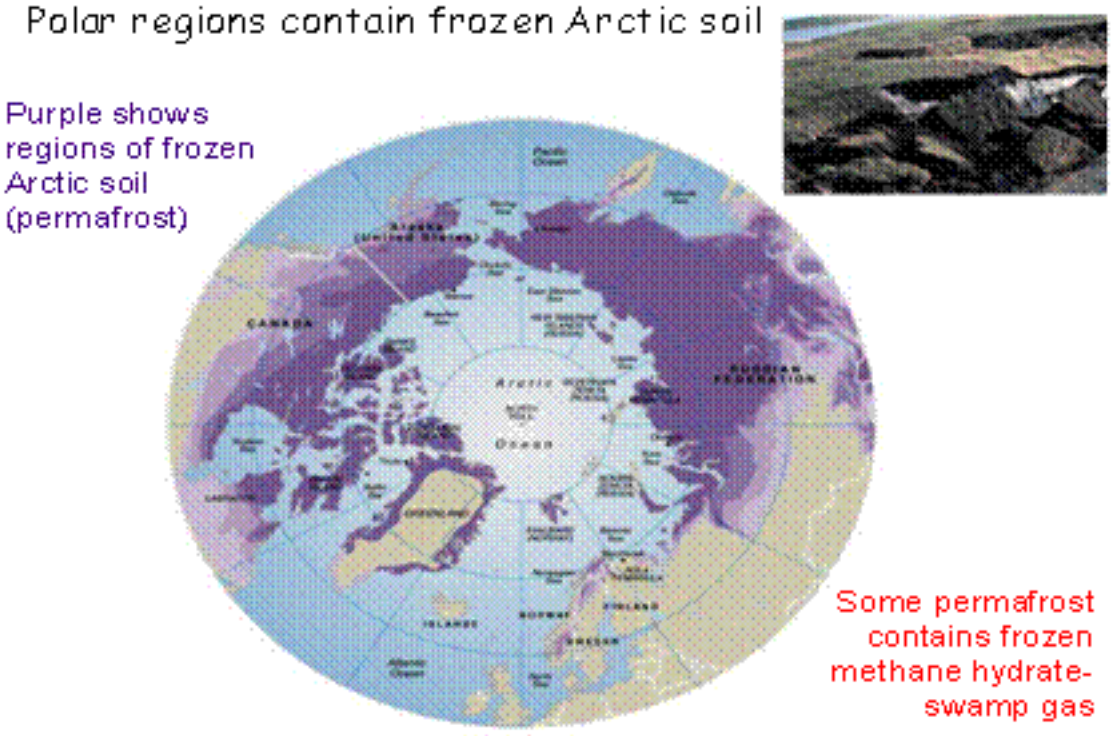


Figure 12.

17. Methane hydrate swamp gas is frozen within the permafrost. It also contains CO_2. There is a big question mark associated with this. We don't know the extent of permafrost, and we know even less precisely the amount of methane and CO_2 contained in these areas. From Dr. Peterson's talk last month we know both chemicals are greenhouse gases, absorbing and re-emitting IR radiation, which warms the Earth's surface and lower atmosphere. This is further shown in figure 13.

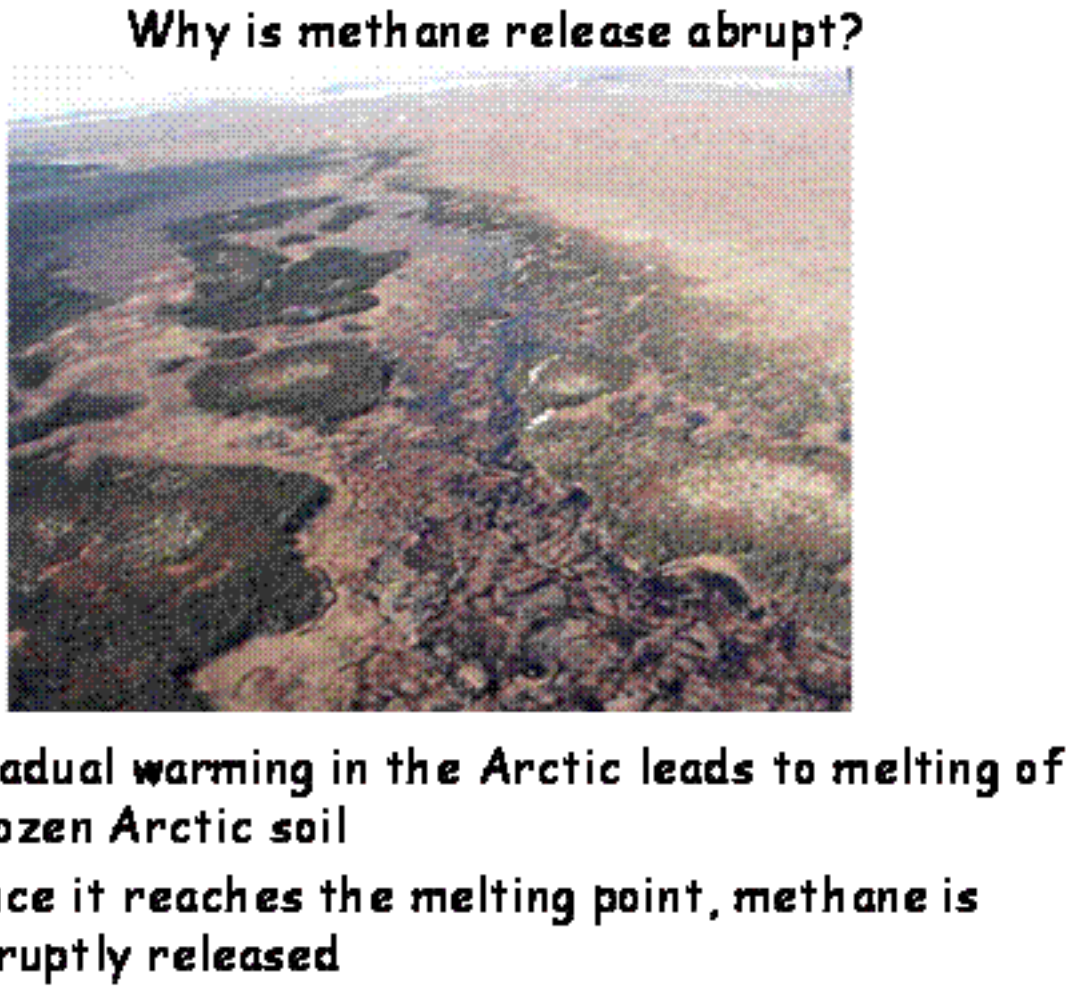


Figure 13. CO_2 is also part of this equation.

18. So, as the temperatures rise, more permafrost melts. Once melted the methane and CO2 that had been frozen within the soil is released to the atmosphere. Once released into the atmosphere these greenhouse gases add to the effectiveness of thermal energy being trapped in the atmosphere and resultant temperature increases. This in turn hastens the permafrost melt. Thus, this produces a feedback mechanism which effectively increases the rate of warming. Given what is predicted in Arctic temperatures, what do the predictions show with respect to future loss in frozen Arctic soil? Figure 14 shows this.

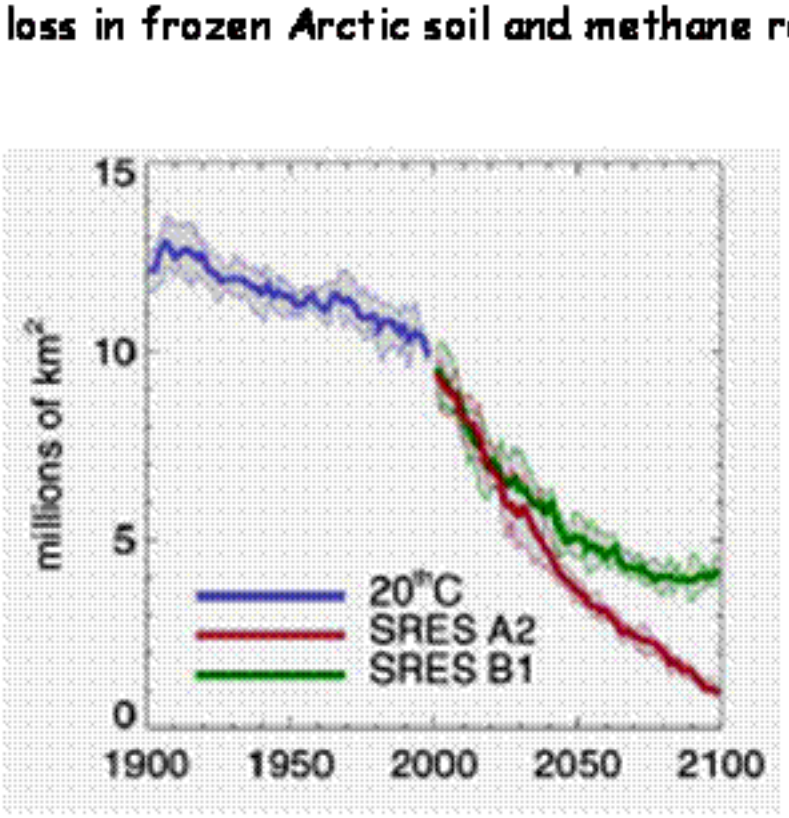


Figure 14. All predictions shown in this figure show an increasing rate of Arctic permafrost melt.

19. Consequences of temperature rises and the resultant rise in sea levels have already been discussed. What are other impacts within the plant and animal kingdom?

Figure 15. Impacts of global warming in the plant and animal kingdom.

20. Polar bears, large and lumbering, will be more susceptible to significant changes in their habitat than small, more transient creatures. The bears depend on large ice flows to support their weight to obtain food from the Arctic Ocean. They also depend on the frozen, solid ground to support their weight. Both are disappearing. Moving farther south for solid ground puts the polar bears into areas without large bodies of water, except around Hudson Bay. But, there the decreasing ice will also be a limiting factor.

21. At the other end of the animal life scale, the pine beetle is benefiting from the warming temperatures. In the Canadian west many days of less than -40 ^{o}F killed many of the over-wintering larvae. As the temperatures warm there is not enough extreme cold to exterminate the young beetles and they thrive. The warmer temperatures have also decreased the life cycle of the beetle from 2 years to 1 year, further increasing the rapid reproduction rate. However, the impact on the pine forests is devastating. The increased temperatures in that region are also causing less rain to fall in the summer, further stressing the pine trees. The following figures show graphs of temperature, drought, and resultant tree mortality. Large areas in the region have nearly total tree mortality, drastically changing the ecology of the region and enhancing the threat of devastating fires.

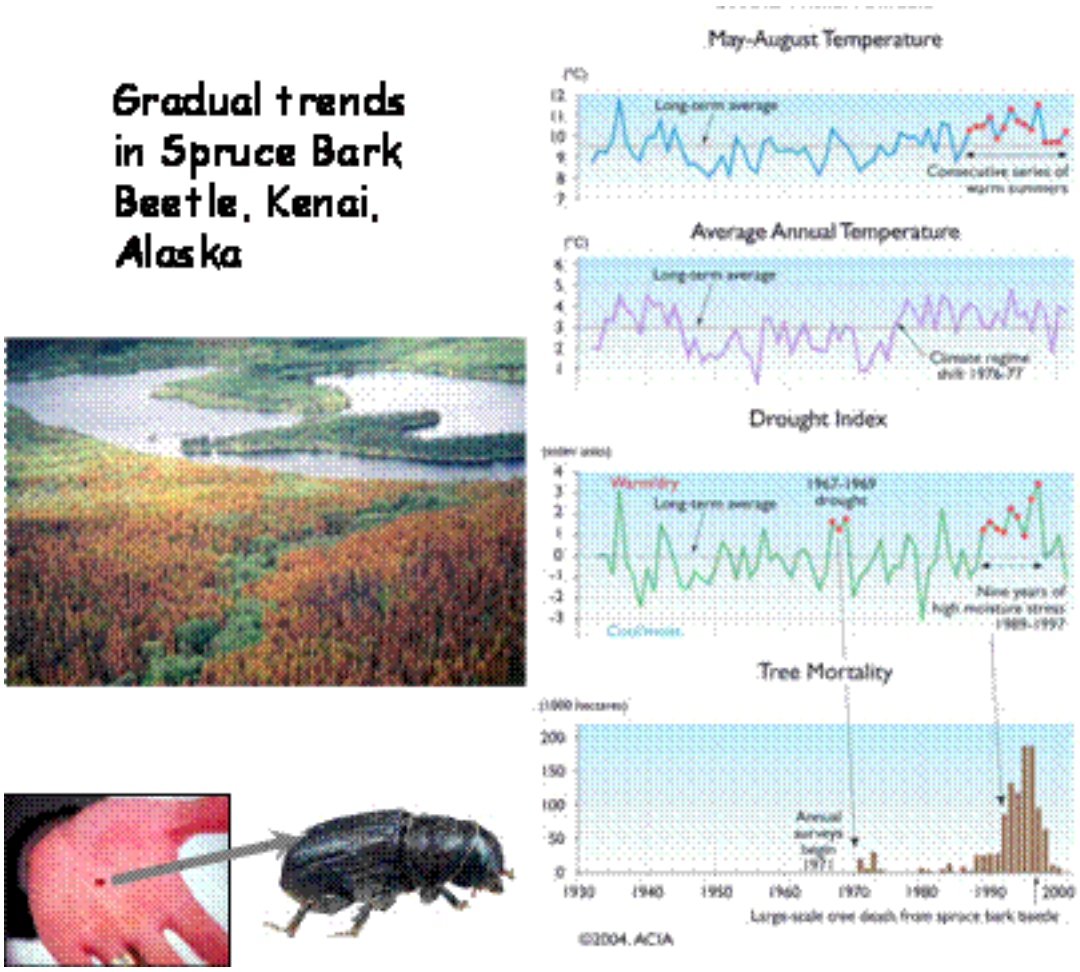


Figure 16. Forests in western North America are being devastated by the pine beetle. Graphs on the right illustrate some of the accompanying reasons.

22. The reliance on ice roads and bridges in the northern winter season is also being negatively impacted. Not only is the ice season shorter, the ice is not as thick. And for air travel, with warmer temperatures resulting in less dense air and the “carrying capacity” simultaneously reduced, longer runways are required to enable aircraft liftoffs. This last factor applies everywhere. Longer runways coupled with shorter ice seasons combine to lower the economic benefits for companies operating in the far north.

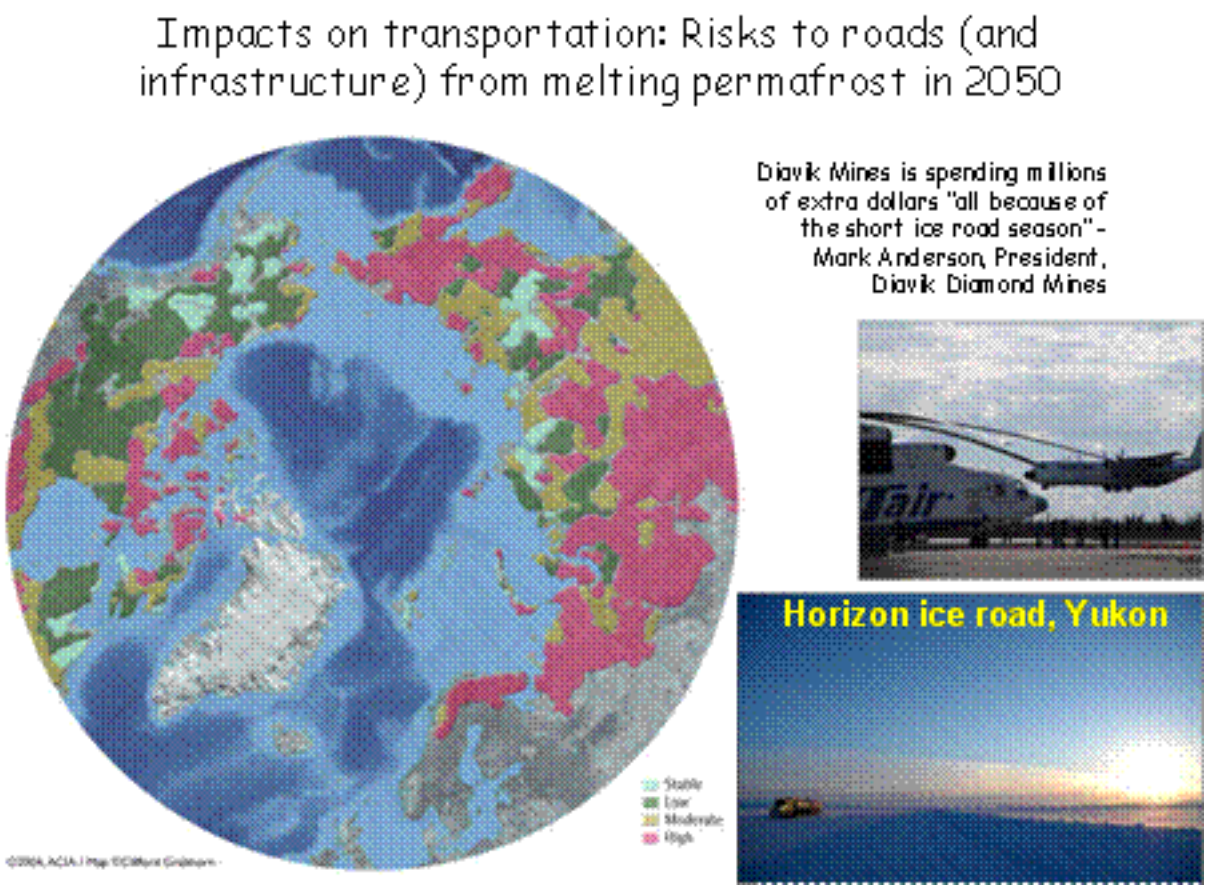


Figure 17. Temperature rises also affect transportation.

23. In conclusion, Dr Anderson stated paleo records reveal the climate has changed abruptly, within decades, in the past and may change abruptly in the future. He also stated gradual climate change can also lead to abrupt consequences, within years, when adapted to a narrow range. What are we doing about it? He stated the United States has been slowly embracing the concept and reality of global warming. As public awareness increases, more political pressure to make meaningful changes will result.

24. Based on questions that followed the formal presentation, additional points were made. While reductions in meridional overturning in the north Atlantic will cool average European temperatures, the overall global trend will still be for warmer temperatures. The Medieval warm period was a combination of natural change plus man-made. For point of comparison the little glacier age 200 years ago was only 1-2 ^{o}C cooler than today. However, increases in temperature by 2100 AD may conservatively average 3-4 ^{o}C higher, 2-3 times the natural change that would be expected over that time span. During climate change the tropics are affected the least, the polar regions the most. As far as Antarctica, we don't yet have a good handle on how sensitive that region will be to global warming. Finally, minute changes in solar radiation and changes in the Earth's orbit do have some play in climate change. The change is subtle, but does drive natural variability.

25. The next meeting will be on April 19th, also in the Folk Art Center. Mr Thomas R. Karl, L.H. D., Director of the National Climatic Data Center, will present a talk on "The U.S. Climatic Change Science Program; the Latest Viewpoint." It will start at 3 p.m.

John D. Gray
Secretary, Asheville Chapter AMS