

## Testimony of Richard S. Lindzen before the Senate Commerce Committee on 1 May 2001.

I wish to thank Senator McCain and the Commerce Committee for the opportunity to clarify the nature of consensus and skepticism in the Climate Debate. I have been involved in climate and climate related research for over thirty years during which time I have held professorships at the University of Chicago, Harvard University and MIT. I am a member of the National Academy of Sciences, and the author or coauthor of over 200 papers and books. I have also been a participant in the proceedings of the IPCC (the United Nation's Intergovernmental Panel on Climate Change). The questions I wish to address are the following: What can we agree on and what are the implications of this agreement? What are the critical areas of disagreement? What is the origin of popular perceptions? I hope it will become clear that the designation, 'skeptic,' simply confuses an issue where popular perceptions are based in significant measure on misuse of language as well as misunderstanding of science. Indeed, the identification of some scientists as 'skeptics' permits others to appear 'mainstream' while denying views held by the so-called 'skeptics' even when these views represent the predominant views of the field.

Climate change is a complex issue where simplification tends to lead to confusion, and where understanding requires thought and effort. Judging from treatments of this issue in the press, the public has difficulty dealing with numerical magnitudes and focuses instead on signs (increasing v. decreasing); science places crucial emphasis on both signs and magnitudes. To quote the great 19<sup>th</sup> Century English scientist, Lord Kelvin, "When you can measure what you are speaking about and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind."

As it turns out, much of what informed scientists agree upon is barely quantitative at all:

- ! that global mean temperature has probably increased over the past century,
- ! that CO<sub>2</sub> in the atmosphere has increased over the same period,
- ! that the added CO<sub>2</sub> is more likely to have caused global mean temperature to increase rather than decrease, and
- ! that man, like the butterfly, has some impact on climate.



Such statements have little relevance to policy, unless quantification shows significance.

The media and advocacy groups have, however, taken this agreement to mean that the same scientists must also agree that global warming "will lead to rising

sea waters, droughts and agriculture disasters in the future if unchecked” (CNN). According to Deb Callahan, president of the League of Conservation Voters, “Science clearly shows that we are experiencing devastating impacts because of carbon dioxide pollution.” (Carbon dioxide, as a ‘pollutant’ is rather singular in that it is a natural product of respiration, non-toxic, and essential for life.) The accompanying cartoon suggests implications for severe weather, the ecosystem, and presumably plague, floods and droughts (as well as the profound politicization of the issue). Scientists who do not agree with the catastrophe scenarios are assumed to disagree with the basic statements. This is not only untrue, but absurdly stupid.

Indeed, the whole issue of consensus and skeptics is a bit of a red herring. If, as the news media regularly report, global warming is the increase in temperature caused by man’s emissions of CO<sub>2</sub> that will give rise to rising sea levels, floods, droughts, weather extremes of all sorts, plagues, species elimination, and so on, then it is safe to say that global warming consists in so many aspects, that widespread agreement on all of them would be suspect *ab initio*. If it truly existed, it would be evidence of a thoroughly debased field. In truth, neither the full text of the IPCC documents nor even the summaries claim any such agreement. Those who insist that the science is settled should be required to state exactly what science they feel is settled. In all likelihood, it will turn out to be something trivial and without policy implications except to those who bizarrely subscribe to the so-called precautionary principle – a matter I will return to later. (Ian Bowles, former senior science advisor on environmental issues at the NSC, published such a remark on 22 April in the Boston Globe: “the basic link between carbon emissions, accumulation of greenhouse gases in the atmosphere, and the phenomenon of climate change is not seriously disputed in the scientific community.” I think it is fair to say that statements concerning matters of such complexity that are not disputed are also likely to be lacking in policy relevant content. However, some policymakers apparently think otherwise in a cultural split that may be worthy of the late C.P. Snow’s attention.)

The thought that there might be a central question, whose resolution would settle matters, is, of course, inviting, and there might, in fact, be some basis for optimism. While determining whether temperature has increased or not is *not* such a question, the determination of climate sensitivity might be. Rather little serious attention has been given to this matter (though I will mention some in the course of this testimony). However, even ignoring this central question, there actually is much that can be learned simply by sticking to matters where there is widespread agreement. For example, there is widespread agreement

- ! that CO<sub>2</sub> levels have increased from about 280ppm to 360ppm over the past century, and, that combined with increases in other greenhouse gases, this brings us about half way to the radiative forcing associated with a doubling of CO<sub>2</sub> without any evidence of enhanced human misery.
- ! that the increase in global mean temperature over the past century is about 1F which is smaller than the normal interannual variability for smaller regions like North America and Europe, and comparable to the interannual variability for the globe. Which is to say

that temperature is always changing, which is why it has proven so difficult to demonstrate human agency.

- ! that doubling CO<sub>2</sub> *alone* will only lead to about a 2F increase in global mean temperature. Predictions of greater warming due to doubling CO<sub>2</sub> are based on positive feedbacks from poorly handled water vapor and clouds (the atmosphere's main greenhouse substances) in current computer models. Such positive feedbacks have neither empirical nor theoretical foundations. Their existence, however, suggests a poorly designed earth which responds to perturbations by making things worse.
- ! that the most important energy source for extratropical storms is the temperature difference between the tropics and the poles which is predicted by computer models to decrease with global warming. This also implies reduced temperature variation associated with weather since such variations result from air moving from one latitude to another. Consistent with this, even the IPCC Policymakers Summary notes that no significant trends have been identified in tropical or extratropical storm intensity and frequency. Nor have trends been found in tornados, hail events or thunder days.
- ! that warming is likely to be concentrated in winters and at night. This is an empirical result based on data from the past century. It represents what is on the whole a beneficial pattern.
- ! that temperature increases observed thus far are less than what models have suggested should have occurred even if they were totally due to increasing greenhouse emissions. The invocation of very uncertain (and unmeasured) aerosol effects is frequently used to disguise this. Such an invocation makes it impossible to check models. Rather, one is reduced to the claim that it is *possible* that models are correct.
- ! that claims that man has contributed any of the observed warming (ie attribution) are based on the assumption that models correctly predict natural variability. Such claims, therefore, do not constitute independent verifications of models. Note that natural variability does not require any *external* forcing – natural or anthropogenic.
- ! that large computer climate models are unable to even simulate major features of past climate such as the 100 thousand year cycles of ice ages that have dominated climate for the past 700 thousand years, and the very warm climates of the Miocene, Eocene, and Cretaceous. Neither do they do well at accounting for shorter period and less dramatic phenomena like El Niños, quasi-biennial oscillations, or intraseasonal oscillations – all of which are well documented in the data, and important contributors to natural variability.
- ! that major past climate changes were either uncorrelated with changes in CO<sub>2</sub> or were characterized by temperature changes which preceded changes in CO<sub>2</sub> by 100's to thousands of years.

- ! that increases in temperature on the order of 1F are not catastrophic and may be beneficial.
- ! that Kyoto, fully implemented, will have little detectable impact on climate regardless of what one expects for warming. This is partly due to the fact that Kyoto will apply only to developed nations. However, if one expected large global warming, even the extension of Kyoto to developing nations would still leave one with large warming.

None of the above points to catastrophic consequences from increasing CO<sub>2</sub>. Most point towards, and all are consistent with minimal impacts. Moreover, the last item provides a definitive disconnect between Kyoto and science. Should a catastrophic scenario prove correct, Kyoto will not prevent it. *If we view Kyoto as an insurance policy, it is a policy where the premium appears to exceed the potential damages, and where the coverage extends to only a small fraction of the potential damages.* Does anyone really want this? I suspect not. Given the rejection of the extensive US concessions at the Hague, it would appear that the Europeans do not want the treaty, but would prefer that the US take the blame for ending the foolishness. As a practical matter, a large part of the response to any climate change, natural or anthropogenic, will be adaptation, and that adaptation is best served by wealth.

Our own research suggests the presence of a major negative feedback involving clouds and water vapor, where models have completely failed to simulate observations (to the point of getting the sign wrong for crucial dependences). If we are right, then models are greatly exaggerating sensitivity to increasing CO<sub>2</sub>. Even if we are not right (which is always possible in science; for example, IPCC estimates of warming trends for the past twenty years were almost immediately acknowledged to be wrong – so too were claims for arctic ice thinning ), the failure of models to simulate observations makes it even less likely that models are a reliable tool for predicting climate.



This brings one to what is probably the major point of disagreement:

*Can one trust computer climate models to correctly predict the response to increasing CO<sub>2</sub>?*

As the accompanying cartoon suggests, our experience with weather forecasts is not particularly encouraging though it may be argued that the prediction of gross climate changes is not as demanding as predicting the

detailed weather. Even here, the situation is nuanced. From the perspective of the *precautionary principle*, it suffices to believe that the existence of a computer prediction of an adverse situation means that such an outcome is *possible* rather than *correct* in order to take ‘action.’ The burden of proof has shifted to proving that the computer prediction is wrong. Such an approach effectively deprives society of science’s capacity to solve problems and answer questions. Unfortunately, the incentive structure in today’s scientific enterprise contributes to this impasse. ***Scientists associate public recognition of the relevance of their subject with support, and relevance has come to be identified with alarming the public.*** It is only human for scientists to wish for support and recognition, and the broad agreement among scientists that climate change is a serious issue must be viewed from this human perspective. Indeed, ***public perceptions have significantly influenced the science itself.*** Meteorologists, oceanographers, hydrologists and others at MIT have all been redesignated climate scientists – indicating the degree to which scientists have hitched their futures to this issue.

That said, it has become common to deal with the science by referring to the IPCC ‘scientific consensus.’ Claiming the agreement of thousands of scientists is certainly easier than trying to understand the issue or to respond to scientific questions; it also effectively intimidates most citizens. However, the ***invocation of the IPCC is more a mantra than a proper reflection on that flawed document.*** The following points should be kept in mind. (Note that almost all reading and coverage of the IPCC is restricted to the highly publicized Summaries for Policymakers which are written by representatives from governments, NGO’s and business; the full reports, written by participating scientists, are largely ignored.) In what follows, I will largely restrict myself to the report of Working Group I (on the science). Working Groups II and III dealt with impacts and responses.

Some problems with the IPCC would appear to stem from the media and advocacy groups.

! ***The media reports rarely reflect what is actually in the Summary.*** The media generally replace the IPCC range of ‘possible’ temperature increases with ‘as much as’ the maximum – despite the highly unlikely nature of the maximum. The range, itself, assumes, unjustifiably, that at least some of the computer models must be correct. However, there is evidence that even the bottom of the range is an overestimate. (A recent study at MIT found that the likelihood of actual change being smaller than the IPCC lower bound was 17 times more likely than that the upper range would even be reached, and even this study assumed natural variability to be what computer models predicted, thus exaggerating the role of anthropogenic forcing.) The media report storminess as a consequence despite the admission in the summary of no such observed relation. To be sure, the summary still claims that such a relation may emerge – despite the fact that the underlying physics suggests the opposite. The media’s emphasis on increased storminess, rising sea levels, etc. is based not on any science, but rather on the fact that such features have more graphic impact than the rather small increases in temperature. People who have experienced day and night and winter and summer have experienced far greater changes in temperature, and retirement to the sun belt rather than

the Northwest Territory represents an overt preference for warmth.

The misuse of the IPCC summaries, however, is not entirely accidental. The IPCC does a number of things which encourage misuse.

- ! Use a summary to misrepresent what scientists say.
- ! Use language which conveys different meaning to laymen and scientists.
- ! Exploit public ignorance (and the embarrassment about this ignorance) over quantitative matters.
- ! Exploit what scientists can agree on in order to support one's agenda.
- ! Exaggerate scientific accuracy and certainty.
- ! Exaggerate the authority of undistinguished scientists.
- ! Pose leading questions (WG II's Impact Report).

With respect to the Summary for Policymakers, the following are more explicit examples.

- ! ***The summary does not reflect the full document (which still has not been released although it was basically completed last August).*** For example, I worked on Chapter 7, Physical Processes. This chapter dealt with the nature of the basic processes which determine the response of climate, and found numerous problems with model treatments – including those of clouds and water vapor. The chapter was summarized with the following sentence: “Understanding of climate processes and their incorporation in climate models have improved, including water vapour, sea-ice dynamics, and ocean heat transport.”
- ! ***The vast majority of participants played no role in preparing the summary, and were not asked for agreement.***
- ! ***The draft of the Policymakers Summary was significantly modified at Shanghai.*** The IPCC, in response to the fact that the Policymakers Summary was not prepared by participating scientists, claimed that the draft of the Summary was prepared by a (selected) subset of the 14 coordinating lead authors. However, the final version of the summary differed significantly from the draft. For example the draft concluded the following concerning attribution:  
*From the body of evidence since IPCC (1996), we conclude that there has been a discernible human influence on global climate. Studies are beginning to separate the contributions to observed climate change attributable to individual external influences, both anthropogenic and natural. This work suggests that anthropogenic greenhouse gases are a substantial contributor to the observed warming, especially over the past 30 years. However, the accuracy of these estimates continues to be limited by uncertainties in estimates of internal variability, natural and anthropogenic forcing, and the climate response to external forcing.*  
The version that emerged from Shanghai concludes instead:

*In the light of new evidence and taking into account the remaining uncertainties, most of the observed warming over the last 50 years is likely to have been due to the increase in greenhouse gas concentrations.*

In point of fact, there may not have been any significant warming in the last 60 years.

Moreover, such warming as may have occurred was associated with jumps that are inconsistent with greenhouse warming.

However, even the report, itself, is biased.

! ***The preparation of the report, itself, was subject to pressure.*** There were usually several people working on every few pages. Naturally there were disagreements, but these were usually hammered out in a civilized manner. However, throughout the drafting sessions, IPCC ‘coordinators’ would go around insisting that criticism of models be toned down, and that ‘motherhood’ statements be inserted to the effect that models might still be correct despite the cited faults. Refusals were occasionally met with ad hominem attacks. I personally witnessed coauthors forced to assert their ‘green’ credentials in defense of their statements.

! The full text can be modified long after the authors have signed off.

None of the above should be surprising. The IPCC was created to support the negotiations concerning CO<sub>2</sub> emission reductions. Although the press frequently refers to the hundreds and even thousands of participants as the world’s leading climate scientists, such a claim is misleading on several grounds. First, climate science, itself, has traditionally been a scientific backwater. There is little question that the best science students traditionally went into physics, math and, more recently, computer science. Thus, speaking of ‘thousands’ of the world’s leading climate scientists is not especially meaningful. Even within climate science, most of the top researchers (at least in the US) avoid the IPCC because it is extremely time consuming and non-productive. Somewhat ashamedly I must admit to being the only active participant in my department. None of this matters a great deal to the IPCC. As a UN activity, it is far more important to have participants from a hundred countries – many of which have almost no active efforts in climate research. For most of these participants, involvement with the IPCC gains them prestige beyond what would normally be available, and these, not surprisingly, are likely to be particularly supportive of the IPCC. Finally, judging from the Citation Index, the leaders of the IPCC process like Sir John Houghton, Dr. Robert Watson, and Prof. Bert Bolin have never been major contributors to basic climate research. They are, however, enthusiasts for the negotiating process without which there would be no IPCC, which is to say that the IPCC represents an interest in its own right. Of course, this hardly distinguishes the IPCC from other organizations.

The question of where do we go from here is an obvious and important one. From my provincial perspective, an important priority should be given to figuring out how to support and encourage science (and basic science underlying climate in particular) while removing incentives to

promote alarmism. The benefits of leaving future generations a better understanding of nature would far outweigh the benefits (if any) of ill thought out attempts to regulate nature in the absence of such understanding. With respect to any policy, the advice given in the 1992 report of the NRC, *Policy Implications of Greenhouse Warming*, remains relevant: carry out only those actions which can be justified independently of any putative anthropogenic global warming. Here, I would urge that even such actions not be identified with climate unless they can be shown to significantly impact the radiative forcing of climate. On neither ground – independent justification or climatic relevance – is Kyoto appropriate.