
**Comments on *Heaven and Earth: Global Warming: The Missing Science***

Today Professor Kurt Lambeck, president of the Australian Academy of Science, discusses Professor Ian Plimer's book *Heaven and Earth*.

**Robyn Williams:** Ian Plimer's book *Heaven and Earth* has been high up in the bestseller list for three or four weeks now. His unswerving dismissal of climate change orthodoxy should come as a surprise to those of us in the general public who expect science to get its facts right, especially in matters which really count, because the stakes couldn't really be higher.

So what's going on? How could one of our best-known geologists, together with some of his like-minded colleagues, be so much at odds with all the leading journals, the academies and most of the specialists in climate studies? We've already had one review on this week in *The Science Show* about earth scientist Professor Malcolm Walter, and it can still be heard online.

Today, for *Ockham's Razor*, we have one of Australia's top scientists, whose job is to assess the merits of research across the nation.

Professor Kurt Lambeck is president of the Australian Academy of Science.

**Kurt Lambeck:** I'm an earth scientist whose research is directed at the interactions between the solid earth, the oceans, ice sheets and atmosphere. And this research is directed not merely to interpret the geological record, but to distinguish between cause and effect, and to understand what may happen when natural and anthropogenic forces clash. In recent years my research has been on sea level change from millions of years to recent times. And this has included geological field work in Australia, Europe, Antarctica, Greenland, amongst other areas, and has given me some insight into at least this one aspect of climate change.

I believe this allows me to conclude that *Heaven and Earth* is not a work of science, it is an opinion of an author who happens to be a scientist.

There is no dispute that the geological record shows that climate change has occurred throughout the earth's history. The dispute is over whether the modern record can be understood in terms of the natural background processes or whether there is a new human factor that changes the rules about climate change.

To address this requires more than geological insight. It requires an understanding of the underlying physical, chemical and biological processes and an ability to model them so as to test alternative hypotheses. To say that geology is the only way to integrate all aspects of the environment is like saying that physicists and chemists should not get involved in biology. How can I take this advice seriously when I see other geologists proclaim with equal conviction, that the record points to imminent planetary doom because of human action?

No single discipline is equipped to handle the complex problems of climate change. Probably nowhere is it more important for the disciplines to come together than in understanding how the components of the solid earth, the oceans, atmosphere and ice sheets, feed off each other and interact in their response to internal and external forcing mechanisms. No single institution and certainly no single individual can do this alone. The problem is simply too complex and this is why processes such as the IPCC are important.

I have been part of the IPCC process and I know that's it's not a perfect one. In seeking consensus, extremes are filtered out. What happens to non-consensus views is that they get tested in the peer-reviewed literature, and if the hypothesis stands up to this probing, it becomes incorporated in subsequent analyses. If it fails to stand up, it will be ignored by the scientific community until new evidence comes to light.

Thus an important part of the synthesis process is that it is an iterative one and if one looks at the successive assessments, one can identify shifts and critiques that have led over time, to improvements in the understanding of climate change.

It is important to recognise that scientists are not consensus animals. We are all driven by our own demons: the satisfaction of being able to understand a particularly complex question, a desire to use science to improve the human condition; a search for recognition and fame and the next Nobel prize or a search for notoriety in the public gallery. Thus the concept that hundreds of researchers are conspiring to defraud the world's policy-makers requires a level of conspiracy theory that not even Dan Brown has reached.

Professor Plimer has said that *Heaven and Earth* is not written for the scientists but for the general public. This is an important objective but it is not an excuse for sloppy science or for the misrepresentation of science. I focus here on the section on sea level, because in his public discussions he has extensively used this to argue that all change is 'natural'.

If this had been written by an honours student, I would have failed it with the comment: You have obviously trawled through a lot of material but the critical analysis is missing. Supporting arguments and unsupported arguments in the literature are not distinguished or properly referenced, and you have left the impression that you have not developed an understanding of the processes involved. Rewrite!

I would then identify a number of specific issues which, while in isolation could be seen as minor, collectively indicate carelessness at best, and at worst an attempt to undermine the integrity of the science case. Here are just a few examples.

There is geological evidence that suggests that the Earth has gone through extreme glacial episodes in the distant past. Plimer states that change from extreme glacial to extreme warm conditions occurred within a few centuries. Whether this is correct or not is a legitimate point of debate. But further on, he states that to raise sea level by 4 to 6 metres from the melting of West Antarctica, in the near future, is Hollywood fantasy. That may well be true. But there is no consistency in his argument. If at one time the planet can exit from near-global glaciation conditions in a few hundred years, then why can a comparatively minor adjustment of the West Antarctica ice sheet not occur on the same time scale? Is it a case of seeing only what you want to see?

Plimer uses the example of ocean floor doming and sea floor volcanism to illustrate geological processes that have modified sea level. He states that during such events monstrous amounts of heat are released into the oceans and that huge volumes of water are displaced, causing sea level to rise. If I use his example of a 1000km x 1000km plateau raised by 1 kilometre, the volume of displaced water is about one million cubic kilometres, which when distributed over the oceans brings sea level up by about 3 metres. But the formation of these plateaux occur on a time scale of a million years and longer, and the associated rate of change is only of the order say, .03 millimetres per year, and this is about 100 times less than the rates observed today. Likewise, Plimer's monstrous amounts of heat released into the oceans do not produce a measurable global signal on the human time scale.

Much research has gone into modelling those kinds of earth deformation in order to understand the long-term, sea-level effects, and realistic order of magnitude estimates can be made. While impressive when viewed on the geological time scales, changes of 100-200 metres over 1 to 100 million years, imply rates of change that are insignificant when compared with the modern record of sea level change.

None of this research is referred to. Instead, he states that models for present sea level rise do not take them into consideration. The peer-reviewed scientific debate is extensive and combative, but there is an accepted conclusion that modern sea level rise, corrected for the geological background signals, can only be explained by a major contribution from thermal expansion of the oceans and from melting of mountain glaciers, and that both of these changes are consistent with the observed and modelled temperature changes during the past century.

Much is made in the book of the difficulty in reaching a reliable assessment of the modern sea-level rise from the instrumental record. From my own work, I agree that the analysis is difficult and not without pitfalls and that in the past different conclusions have been reached because some of these pitfalls were not recognised. But with time these have been addressed, new data has been identified, and analysis methods have improved. To argue therefore that because there are discrepancies with superseded results we cannot believe any of the results is to take a strange view of the process of science. There is in fact a quite remarkable convergence of the interpretation of the observational evidence of what has been happening to sea level in the past 100 or so years. This points to an increase in the globally averaged rates by a factor of about 2, and this is consistent with what is expected from the climate models that include both natural and anthropogenic forcing. None of this is discussed in the book.

To give his arguments a semblance of respectability the book is replete with references. But the choice is very selective. Plimer will quote, for example, a paper that appears to support his argument, but then he does not mention that the conclusions therein have been completely refuted in subsequent papers. Elsewhere, he refers to a specific question raised in published work but does not mention that this issue has subsequently been resolved, has been incorporated in subsequent analyses, and is no longer relevant. Or he simply misquotes the work or takes it out of context. An example of this is a reference to my own in the Mediterranean where he gives quite a misleading twist to what we actually concluded.

Other examples can be identified in this section, and throughout the book. Together they point to either carelessness, to a lack of understanding of the underlying science, or to an attempt to see the world through tinted spectacles.

But why do I really care? There is no doubt that climate change has occurred from the time the planet first acquired its atmosphere. What we also learn from the geological record is that the planet's 'mood' swings are finely balanced: that the shift from one state to another can be sudden on the geological timescales. For the last million years it has swung between major glaciations and the more temperate periods like today within which homo sapiens has made its home.

Our understanding of these cycles is of a delicate balance between external forcing, in this case solar insolation caused by variations in the geometry of the earth's orbit and its rotation axis, and complex feedback mechanisms involving the oceans, ice sheets and biological and surface processes. The present climate system shows all the hallmarks of an unstable system tenuously held under control by the astronomical forcing and perturbed at intervals by other forcing such as the injection of volcanic dust and gases into the atmosphere.

We also have a good understanding of the basic physics and chemistry of the atmosphere and oceans and of the nature of the various feedback mechanisms. What we have learned is that the changes of the past 100 years cannot be quantitatively expressed by natural processes alone. Only the addition of greenhouse gases lead to a satisfactory explanation of what has been observed and all the recent results are showing that the changes in temperature, in sea level, and in ocean acidification are tracking near the upper levels of the IPCC forecasts. This is a matter for concern whose underpinning science needs to be debated.

For us, the questions are: can 9-billion people in 2050 survive if there is a global disruption of our climate during this century? Do the costs of such disruption exceed the short-term costs of implementing technologies and practices that lead to a stabilisation of greenhouse gas emissions? How can the technologies and changes in lifestyle be implemented without causing their own disruptions?

The science community has the responsibility to provide the best evidence to help our policymakers reach conclusions that are founded in science, that are based on our best current understanding. This is in the interests of society as a whole, not only of particular interest groups. Spreading confusion through poorly argued science does not help in addressing this question.

**Robyn Williams:** Professor Kurt Lambeck is President of the Australian Academy of Science, and as you heard, an earth scientist. The book he was discussing is *Heaven and Earth* by Ian Plimer, who's now based at the University of Adelaide.