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Global Warming for the Two Cultures

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Theme: Environment, Media Disinformation, Science and Medicine

We bring this authoritative analysis by Professor Richard Lindzen to the attention of our readers, as well as those actively involved in the Climate Debate and the Protest Movement.

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Professor Richard S. Lindzen (Selected excerpts from complete text below)

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emphasis added [GR]

Over half a century ago, C.P. Snow (a novelist and English physical chemist who also served in several important positions in the British Civil Service and briefly in the UK government) famously examined the implications of 'two cultures':

> A good many times I have been present at gatherings of people who, by the standards of the traditional culture, are thought highly educated and who have with considerable gusto been expressing their incredulity at the illiteracy of scientists. Once or twice I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics. The

> response was cold: it was also negative. Yet I was asking something which is the scientific equivalent of: Have you read a work of Shakespeare's?
>
> I now believe that if I had asked an even simpler question – such as, What do you mean by mass, or acceleration, which is the scientific equivalent of saying, Can you read? – not more than one in ten of the highly educated would have felt that I was speaking the same language. So the great edifice of modern physics goes up, and the majority of the cleverest people in the western world have about as much insight into it as their Neolithic ancestors would have had.

I fear that little has changed since Snow's assessment 60 years ago. While some might maintain that ignorance of physics does not impact political ability, it most certainly impacts the ability of non-scientific politicians to deal with nominally science-based issues. The gap in understanding is also an invitation to malicious exploitation. Given the democratic necessity for non-scientists to take positions on scientific problems, belief and faith inevitably replace understanding, though trivially oversimplified false narratives serve to reassure the non-scientists that they are not totally without scientific 'understanding.' The issue of global warming offers numerous examples of all of this.

I would like to begin this lecture with an attempt to force the scientists in the audience to come to grips with the actual nature of the climate system, and to help the motivated non-scientists in this audience who may be in Snow's 'one in ten' to move beyond the trivial oversimplifications.

The climate system

The following description of the climate system contains nothing that is in the least controversial, and I expect that anyone with a scientific background will readily follow the description. I will also try, despite Snow's observations, to make the description intelligible to the non-scientist.

The system we are looking at consists in two turbulent fluids (the atmosphere and the oceans) interacting with each other. By 'turbulent,' I simply mean that it is characterized by irregular circulations like those found in a gurgling brook or boiling water, but on the planetary scale of the oceans and the atmosphere. The opposite of turbulent is called laminar, but any fluid forced to move fast enough becomes turbulent, and turbulence obviously limits predictability. By interaction, I simply mean that they exert stress on each other and exchange heat with each other.

These fluids are on a rotating planet that is unevenly heated by the sun. The motions in the atmosphere (and to a lesser extent in the oceans) are generated by the uneven influence of the sun. The sun, itself, can be steady, but it shines directly on the tropics while barely skimming the Earth at the poles. The drivers of the oceans are more complex and include forcing by wind as well as the sinking of cold and salty water. The rotation of the Earth has many consequences too, but for the present, we may simply note that it leads to radiation being distributed around a latitude circle.

The oceans have circulations and currents operating on time scales ranging from years to millennia, and these systems carry heat to and from the surface. Because of the scale and density of the oceans, the flow speeds are generally much smaller than in the atmosphere and are associated with much longer timescales. The fact that these circulations carry heat to and from the surface means that the surface, itself, is never in equilibrium with space.

That is to say, there is never an exact balance between incoming heat from the sun and outgoing radiation generated by the Earth because heat is always being stored in and released from the oceans and surface temperature is always, therefore, varying somewhat.

In addition to the oceans, the atmosphere is interacting with a hugely irregular land surface. As air passes over mountain ranges, the flow is greatly distorted. Topography therefore plays a major role in modifying regional climate. These distorted air-flows even generate fluid waves that can alter climate at distant locations. Computer simulations of the climate generally fail to adequately describe these effects.

A vital constituent of the atmospheric component is water in the liquid, solid and vapor phases, and the changes in phase have vast impacts on energy flows. Each component also has important radiative impacts. You all know that it takes heat to melt ice, and it takes further heat for the resulting water to become vapor or, as it is sometimes referred to, steam. The term humidity refers to the amount of vapor in the atmosphere. The flow of heat is reversed when the phase changes are reversed; that is, when vapor condenses into water, and when water freezes. The release of heat when water vapor condenses drives thunder clouds (known as cumulonimbus), and the energy in a thundercloud is comparable to that released in an H-bomb. I say this simply to illustrate that these energy transformations are very substantial. Clouds consist of water in the form of fine droplets and ice in the form of fine crystals. Normally, these fine droplets and crystals are suspended by rising air currents, but when these grow large enough they fall through the rising air as rain and snow. Not only are the energies involved in phase transformations important, so is the fact that both water vapor and clouds (both ice- and water-based) strongly affect radiation. Although I haven't discussed the greenhouse effect yet, I'm sure all of you have heard that carbon dioxide is a greenhouse gas and that this explains its warming effect. You should, therefore, understand that the two most important greenhouse substances by far are water vapor and clouds. Clouds are also important reflectors of sunlight.

The unit for describing energy flows is watts per square meter. The energy budget of this system involves the absorption and reemission of about 200 watts per square meter. Doubling CO2 involves a 2% perturbation to this budget. So do minor changes in clouds and other features, and such changes are common. The Earth receives about 340 watts per square meter from the sun, but about 140 watts per square meter is simply reflected back to space, by both the Earth's surface and, more importantly, by clouds. This leaves about 200 watts per square meter that the Earth would have to emit in order to establish balance. The sun radiates in the visible portion of the radiation spectrum because its temperature is about 6000K. 'K' refers to Kelvins, which are simply degrees Centigrade plus 273. Zero K is the lowest possible temperature (-273°C). Temperature determines the spectrum of the emitted radiation. If the Earth had no atmosphere at all (but for purposes of argument still was reflecting 140 watts per square meter), it would have to radiate at a temperature of about 255K, and, at this temperature, the radiation is mostly in the infrared.

Of course, the Earth does have an atmosphere and oceans, and this introduces a host of complications. So be warned, what follows will require a certain amount of concentration. Evaporation from the oceans gives rise to water vapor in the atmosphere, and water vapor very strongly absorbs and emits radiation in the infrared. This is what we mean when we call water vapor a greenhouse gas. The water vapor essentially blocks infrared radiation from leaving the surface, causing the surface and (via conduction) the air adjacent to the surface to heat, and, as in a heated pot of water, convection sets on. Because the density of air decreases with height, the buoyant elements expand as they rise. This causes the buoyant

elements to cool as they rise, and the mixing results in decreasing temperature with height rather than a constant temperature. To make matters more complicated, the amount of water vapor that the air can hold decreases rapidly as the temperature decreases. At some height there is so little water vapor above this height that radiation from this level can now escape to space. It is at this elevated level (around 5 km) that the temperature must be about 255K in order to balance incoming radiation.

However, because convection causes temperature to decrease with height, the surface now has to actually be warmer than 255K. It turns out that it has to be about 288K (which is the average temperature of the Earth's surface). This is what is known as the greenhouse effect. It is an interesting curiosity that had convection produced a uniform temperature, there wouldn't be a greenhouse effect. In reality, the situation is still more complicated. Among other things, the existence of upper-level cirrus clouds, which are very strong absorbers and emitters of infrared radiation, effectively block infrared radiation from below. Thus, when such clouds are present above about 5 km, their tops rather than the height of 5 km determine the level from which infrared reaches space. Now the addition of other greenhouse gases (like carbon dioxide) elevates the emission level, and because of the convective mixing, the new level will be colder. This reduces the outgoing infrared flux, and, in order to restore balance, the atmosphere would have to warm. Doubling carbon dioxide concentration is estimated to be equivalent to a forcing of about 3.7 watts per square meter, which is little less than 2% of the net incoming 200 watts per square meter. Many factors, including cloud area and height, snow cover, and ocean circulations, commonly cause changes of comparable magnitude.

It is important to note that such a system will fluctuate with time scales ranging from seconds to millennia, even in the absence of an explicit forcing other than a steady sun. Much of the popular literature (on both sides of the climate debate) assumes that all changes must be driven by some external factor. Of course, the climate system is driven by the sun, but even if the solar forcing were constant, the climate would still vary. This is actually something that all of you have long known – even if you don't realize it. After all, you have no difficulty recognizing that the steady stroking of a violin string by a bow causes the string to vibrate and generate sound waves. In a similar way, the atmosphere–ocean system responds to steady forcing with its own modes of variation (which, admittedly, are often more complex than the modes of a violin string). Moreover, given the massive nature of the oceans, such variations can involve timescales of millennia rather than milliseconds. El Niño is a relatively short example, involving years, but most of these internal time variations are too long to even be identified in our relatively short instrumental record. Nature has numerous examples of autonomous variability, including the approximately 11-year sunspot cycle and the reversals of the Earth's magnetic field every couple of hundred thousand years or so. In this respect, the climate system is no different from other natural systems.

Of course, such systems also do respond to external forcing, but such a forcing is not needed for them to exhibit variability. While the above is totally uncontroversial, please think about it for a moment. Consider the massive heterogeneity and complexity of the system, and the variety of mechanisms of variability as we consider the current narrative that is commonly presented as 'settled science.'

The popular narrative and its political origins

Now here is the currently popular narrative concerning this system. The climate, a complex multifactor system, can be summarized in just one variable, the globally averaged temperature change, and is primarily controlled by the 1-2% perturbation in the energy budget due to a single variable – carbon dioxide – among many variables of comparable importance.

This is an extraordinary pair of claims based on reasoning that borders on magical thinking. It is, however, the narrative that has been widely accepted, even among many sceptics. This acceptance is a strong indicator of the problem Snow identified.

Many politicians and learned societies go even further: They endorse carbon dioxide as the controlling variable, and although mankind's CO2 contributions are small compared to the much larger but uncertain natural exchanges with both the oceans and the biosphere, they are confident that they know precisely what policies to implement in order to control carbon dioxide levels.

While several scientists have put forward this view over the past 200 years, it was, until the 1980s, generally dismissed. When, in 1988, the NASA scientist, James Hansen, testified to the US Senate that the summer's warmth reflected increased CO2, even Science magazine reported that the climate science community was sceptical. The establishment of this extreme position as dogma during the present period is due to political actors and others seeking to exploit the opportunities that abound in the multi-trillion-dollar energy sector. One example was Maurice Strong, a global bureaucrat and wheeler-dealer (who spent his final years in China apparently trying to avoid prosecution for his role in the UN's Oil for Food program scandals). Strong is frequently credited with initiating the global warming movement in the early 1980s and he subsequently helped to engineer the Rio Conference that produced the UN Framework Convention on Climate Change. This was the agreement that endorsed the CO2-climate narrative, and initiated the series of international meetings (that continue to the present) to plan the control of climate. However, others like the Swedish Prime Minister, Olaf Palme, and his friend and science advisor, Bert Bolin, who was the first chairman of the Intergovernmental Panel on Climate Change (IPCC), had also begun exploiting this issue as early as the 1970s. Their motivation was to overcome the resistance to nuclear energy by demonizing coal.

Political enthusiasm has only increased since then as political ideology has come to play a major role. A few years ago, Christiana Figueres, then executive secretary of UN Framework Convention on Climate Change, said that mankind was, for the first time in history, setting itself the task of intentionally changing the economic system.2

Ms. Figueres is not alone in believing this. Pope Francis' closest adviser castigated conservative climate change skeptics in the United States, blaming capitalism for their views. Speaking with journalists, Cardinal Oscar Rodríguez Maradiaga criticized 'movements' in the United States that had preemptively come out in opposition to Francis's planned encyclical on climate change. 'The ideology surrounding environmental issues is too tied to a capitalism that doesn't want to stop ruining the environment because they don't want to give up their profits', he said.

This past August, a paper appeared in the Proceedings of the National Academy of Sciences. Littered with 'could bes' and 'might bes', it conclude that 'Collective human action' is required to 'steer the Earth System away from a potential threshold' and keep it habitable. The authors said that this would involve 'stewardship of the entire Earth System –

biosphere, climate, and societies', and that it might involve 'decarbonization of the global economy, enhancement of biosphere carbon sinks, behavioral changes, technological innovations, new governance arrangements, and transformed social values'.

Remember, in a world that buys into the incoherent 'precautionary principle,' even the mere claim of remote possibility justifies extreme action.

Presumably, the power these people desperately seek includes the power to roll back the status and welfare that the ordinary person has acquired and continues to acquire through the fossil fuel generated industrial revolution and return them to their presumably more appropriate status as serfs. Many more among the world's poorest will be forbidden the opportunity to improve their condition.

Nevertheless, when these claims are presented to the leaders of our societies, along with the bogus claim that 97% of scientists agree, our leaders are afraid to differ, and proceed, lemming-like, to plan for the suicide of industrial society. Again, nothing better illustrates the problem that Snow identified.

Interestingly, however, 'ordinary' people (as opposed to our 'educated' elites) tend to see through the nonsense being presented. What is it about our elites that makes them so vulnerable, and what is it about many of our scientists that leads them to promote such foolishness? The answers cannot be very flattering to either. Let us consider the 'vulnerable' elites first.

1. They have been educated in a system where success has been predicated on their ability to please their professors. In other words, they have been conditioned to rationalize anything.

2. While they are vulnerable to false narratives, they are far less economically vulnerable than are ordinary people. They believe themselves wealthy enough to withstand the economic pain of the proposed policies, and they are clever enough to often benefit from them.

3. The narrative is trivial enough for the elite to finally think that they 'understand' science.

4. For many (especially on the right), the need to be regarded as intelligent causes them to fear that opposing anything claimed to be 'scientific' might lead to their being regarded as ignorant, and this fear overwhelms any ideological commitment to liberty that they might have.

None of these factors apply to 'ordinary' people. This may well be the strongest argument for popular democracy and against the leadership of those 'who know best.'

What about the scientists?

1. Scientists are specialists. Few are expert in climate. This includes many supposed 'climate scientists' who became involved in the area in response to the huge increases in funding that have accompanied global warming hysteria.

2. Scientists are people with their own political positions, and many have been enthusiastic about using their status as scientists to promote those positions (not unlike

celebrities whose status some scientists often aspire to). As examples, consider the movements against nuclear weapons, against the Strategic Defense Initiative, against the Vietnam War, and so on.

Scientists are also acutely and cynically aware of the ignorance of non-scientists and the fear that this engenders. This fear leaves the 'vulnerable' elites particularly relieved by assurances that the theory underlying the alarm is trivially simple and that 'all' scientists agree. Former senator and Secretary of State John F. Kerry is typical when he stated, with reference to greenhouse warming, 'I know sometimes I can remember from when I was in high school and college, some aspects of chemistry or physics can be tough. But this is not tough. This is simple. Kids at the earliest age can understand this'. As you have seen, the greenhouse effect is not all that simple. Only remarkably brilliant kids would understand it. Given Kerry's subsequent description of climate and its underlying physics, it was clear that he was not up to the task.

The evidence

At this point, some of you might be wondering about all the so-called evidence for dangerous climate change. What about the disappearing Arctic ice, the rising sea level, the weather extremes, starving polar bears, the Syrian Civil War, and all the rest of it? The vast variety of the claims makes it impossible to point to any particular fault that applies to all of them. Of course, citing the existence of changes – even if these observations are correct (although surprisingly often they are not) – would not implicate greenhouse warming per se. Nor would it point to danger. Note that most of the so-called evidence refers to matters of which you have no personal experience. Some of the claims, such as those relating to weather extremes, contradict what both physical theory and empirical data show. The purpose of these claims is obviously to frighten and befuddle the public, and to make it seem like there is evidence where, in fact, there is none. If there is evidence of anything, it is of the correctness of C.P. Snow's observation. Some examples will show what I mean.

First, for something to be evidence, it must have been unambiguously predicted. (This is a necessary, but far from sufficient condition.) Figure 1 shows the IPCC model forecasts for the summer minimum in Arctic sea ice in the year 2100 relative to the period 1980–2000. As you can see, there is a model for any outcome. It is a little like the formula for being an expert marksman: shoot first and declare whatever you hit to be the target.

Turning to the issue of temperature extremes, is there any data to even support concern? As to these extremes, the data shows no trend and the IPCC agrees. Even Gavin Schmidt, Jim Hansen's successor at NASA's New York shop, GISS, has remarked that 'general statements about extremes are almost nowhere to be found in the literature but seem to abound in the popular media'. He went on to say that it takes only a few seconds' thought to realise that the popular perceptions that 'global warming means all extremes have to increase all the time' is 'nonsense'.

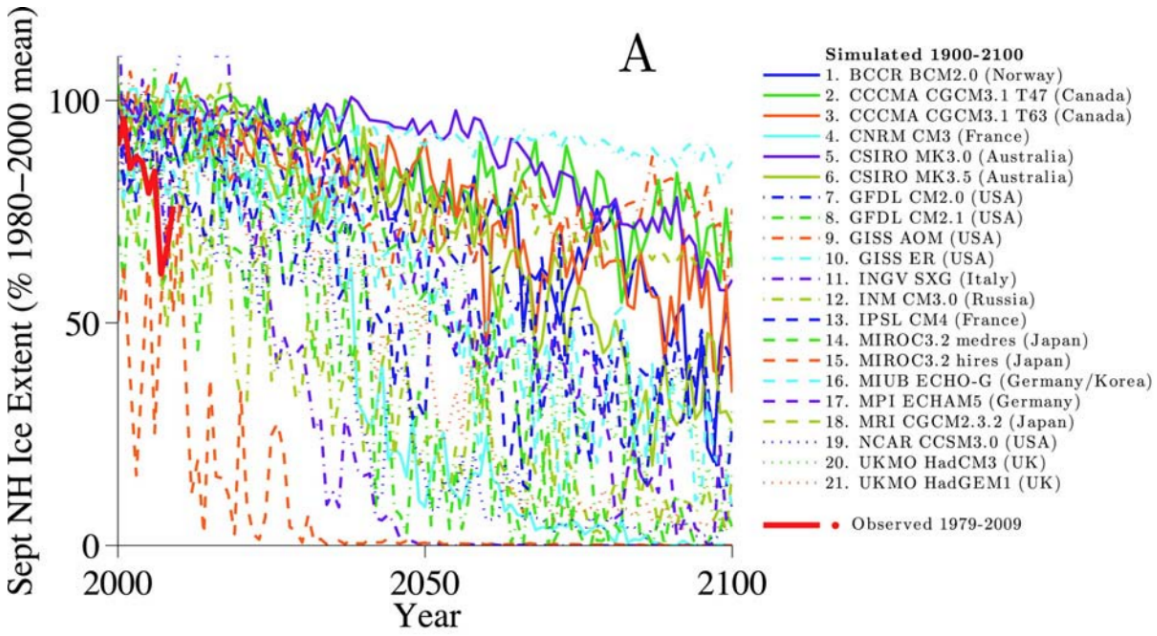

Figure 1: Climate model projections of rate of Arctic sea ice loss.
Source: Eisenman *et al.*, *J. Clim.*, 2011.

At the heart of this nonsense is the failure to distinguish weather from climate. Thus, global warming refers to the welcome increase in temperature of about 1◦C since the end of the Little Ice Age about 200 years ago. On the other hand, weather extremes involve temperature changes of the order of 20◦C. Such large changes have a profoundly different origin from global warming. Crudely speaking, they result from winds carrying warm and cold air from distant regions that are very warm or very cold. These winds are in the form of waves. The strength of these waves depends on the temperature difference between the tropics and the Arctic (with larger differences leading to stronger waves). Now, the models used to project global warming all predict that this temperature difference will decrease rather than increase. Thus, the increase in temperature extremes would best support the idea of global cooling rather than global warming. However, scientifically illiterate people seem incapable of distinguishing global warming of climate from temperature extremes due to weather. In fact, as has already been noted, there doesn't really seem to be any discernible trend in weather extremes. There is only the greater attention paid by the media to weather, and the exploitation of this 'news' coverage by people who realize that projections of catastrophe in the distant future are hardly compelling, and that they therefore need a way to convince the public that the danger is immediate, even if it isn't.

This has also been the case with sea-level rise. Sea level has been increasing by about 8 inches per century for hundreds of years, and we have clearly been able to deal with it. In order to promote fear, however, those models that predict much larger increases are invoked. As a practical matter, it has long been known that at most coastal locations, changes in sea level, as measured by tide gauges, are primarily due to changes in land level associated with both tectonics and land use.

Moreover, the small change in global mean temperature (actually the change in temperature increase) is much smaller than what the computer models used by the IPCC have predicted. Even if all this change were due to man, it would be most consistent with low sensitivity to added carbon dioxide, and the IPCC only claims that most (not all) of the warming over the past 60 years is due to man's activities. Thus, the issue of man-made

climate change does not appear to be a serious problem. However, this hardly stops ignorant politicians from declaring that the IPCC's claim of attribution is tantamount to unambiguous proof of coming disaster.

Cherry picking is always an issue. Thus, there has been a recent claim that Greenland ice discharge has increased, and that warming will make it worse.3 Omitted from the report is the finding by both NOAA and the Danish Meteorological Institute that the ice mass of Greenland has actually been increasing.4 In fact both these observations can be true, and, indeed, ice build-up pushes peripheral ice into the sea.

Misrepresentation, exaggeration, cherry picking, or outright lying pretty much covers all the so-called evidence.

Conclusion

So there you have it. An implausible conjecture backed by false evidence and repeated incessantly has become politically correct 'knowledge,' and is used to promote the overturn of industrial civilization. What we will be leaving our grandchildren is not a planet damaged by industrial progress, but a record of unfathomable silliness as well as a landscape degraded by rusting wind farms and decaying solar panel arrays. False claims about 97% agreement will not spare us, but the willingness of scientists to keep mum is likely to much reduce trust in and support for science. Perhaps this won't be such a bad thing after all – certainly as concerns 'official' science.

There is at least one positive aspect to the present situation. None of the proposed policies will have much impact on greenhouse gases. Thus we will continue to benefit from the one thing that can be clearly attributed to elevated carbon dioxide: namely, its effective role as a plant fertilizer, and reducer of the drought vulnerability of plants. Meanwhile, the IPCC is claiming that we need to prevent another 0.5◦C of warming, although the 1◦C that has occurred so far has been accompanied by the greatest increase in human welfare in history. As we used to say in my childhood home of the Bronx: 'Go figure'.

Richard S. Lindzen was Alfred P. Sloan Professor of Meteorology at the Massachusetts Institute of Technology until his retirement in 2013. He is the author of over 200 papers on meteorology and climatology and is a member of the US National Academy of Sciences and of the Academic Advisory Council of GWPF.

This published version of the lecture contains minor editorial changes to the text as delivered by Professor Lindzen.

Notes

1. Lawson N. (2008) An Appeal to Reason: A Cool Look at Global Warming. Overlook Duckworth.

2. 'This is the first time in the history of mankind that we are setting ourselves the task of intentionally, within a defined period of time, to change the economic development model that has been reigning for at least 150 years, since the Industrial Revolution.'

3. KA Graeter et al. (2018) Ice core records of West Greenland melt and climate forcing. Geophysical Research Letters 45(7), 3164–3172.

4.

https://www.climate.gov/news-features/understanding-climate/greenland-ice-sheets2017-weigh-suggests-small-increase-ice-mass.
