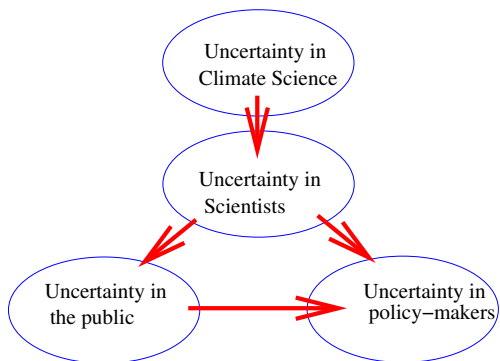


Challenges of Climate Change .5 Lecture 4: Uncertainty

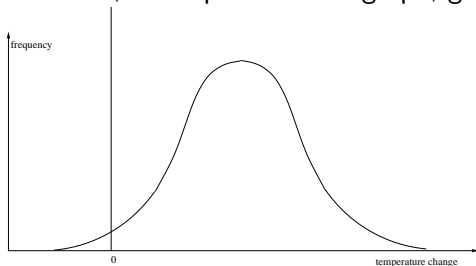
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Uncertainty



Global mean temperature

Mean temperatures are measured at a vast number of sites, and the results, when plotted on a graph, give something like this:

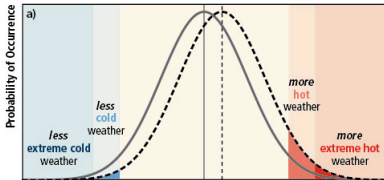


How strong is this as evidence that temperatures have changed? In this graph, some temperatures have gone down, while it seems that more have gone up. It is conventional to quantify the strength of evidence for warming provided by a graph of this kind as

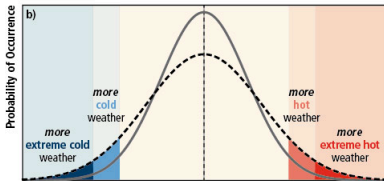
$$\frac{\text{Area under the graph to the right of 0}}{\text{total area under graph}}$$

The next slides show some cartoon graphs from the IPCC illustrating some consequences of possible changes to the distribution of temperatures.

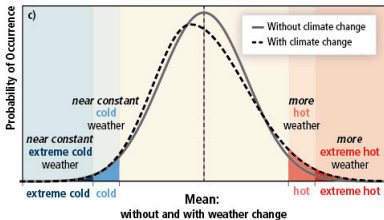
Shifted Mean



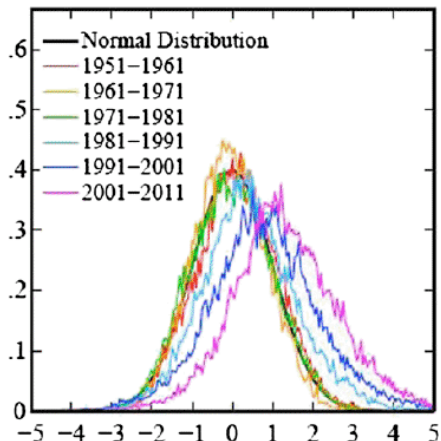
Increased Variability



Changed Symmetry



1951-1980



Graphs from briefing by James Hansen available at www.gis.nasa.gov/research/briefs/hansen_17/

Doubt on the data

Doubts on the existence of global warming (though not its causes) might well be resolved by a graph of the kind just shown, assuming its measurements were trusted. Unfortunately the data is subject to a great deal of doubt. Proxy data such as tree ring and ice core measurements rely on the hypothesis that “all other things were equal”, and so are the subject of debate. Contemporary measurements may be affected by local increases in temperature due to urbanisation. Some measurements from China have been cast into doubt for this reason - information on some geographical locations was lost, and it is not known whether they have urbanised.

Old thermometers may have been inaccurate!

Part II: Science is not the only source of uncertainty

Despite the reasons for uncertainty in science, there is practically a universal consensus among climate scientists that the climate is changing and that carbon emissions are the cause.

IPCC reports say this more and more strongly; the 2013 report has 95% confidence that at least half of the temperature changes are due to human agency, up from 90% in the previous report.

The media do not reflect this consensus. When BBC Radio 4 discussed the IPCC report shortly after its publication in 2013, their Today item at 8.00am reported that they couldn't find a climate scientist in the UK who would dispute the findings of the IPCC. For their World at One news programme, they did find a sceptic: a retired geologist from Australia, Bob Carter, who leads the Nongovernmental International Panel on Climate Change, funded by US conservatives and in particular by the Heartland Institute.

Carter's interview dominated the World at One coverage of the IPCC report, and reporting in several later bulletins.

The BBC argues the need for "fairness and balance".

It has been criticised for "false balance" by Professor Steve Jones, a biologist from University College London, who it had commissioned to review its science reporting.

Other media outlets with less commitment to public service are more obviously influenced by commercial imperatives: controversy is exciting, agreement is dull.

Do we jeopardise our own future by confusing information with entertainment?

Merchants of Doubt

There is something more organised going on. A number of politically conservative foundations in the US promote denial, and not just of climate change. Naomi Oreskes and Erik Conway show in “Merchants of Doubt” (2010) how some of the same people and organisations have repeatedly promoted doubt

- ▶ That smoking causes cancer
- ▶ That sulphur emissions in smoke cause acid rain
- ▶ That CFCs cause ozone depletion
- ▶ That passive smoking damages health, and now
- ▶ That carbon from burning fossil fuels is causing dangerous climate change

Oreskes and Conway follow four distinguished physicists, Fred Seitz, former president of the National Academy of Science of the USA, Fred Singer, Robert Jastrow and William Nierenberg, who have been involved in creating uncertainty on all of these issues. The open letter to Ben Santer available at www.ucar.edu/communications/quarterly/summer96/insert.html

documents some of the disreputable tactics they have employed. Common features of the scientific debates in which they intervened:

- ▶ In every case, the science suggested a need for government regulation. Is it opposition to regulation that drives them? Seitz and Singer were noted hawks during the Cold War, and all four are (or were - all but Singer are now dead) political conservatives. Did they see government regulation of tobacco/CFCs/CO₂ emissions as blows against the free market in a continuing Cold War? (Reciprocal question: do “climate activists” see things in just that way? What has climate change got to do with Left and Right?)
- ▶ Funding for their contrarian positions comes from large corporations which stand to suffer economically in case regulations are imposed. The case of tobacco is instructive: ethics were consistently overruled by the need to do business. We should expect the same with regard to climate.
- ▶ In each case, the science asserts that our doing A causes B. In each case, B has several possible causes, and it is possible to increase doubt about the extent to which A is to blame.

Attributing blame

Climate change is a particularly extreme case. It is hard to attribute blame. Are these consequences of climate change?



Somali refugees from drought and warfare



Drowned cabs in New Jersey after Super-Storm Sandy.

Attributing blame

Is climate change to blame for these events?

In a complex system, events have many causes. If I say

“I’m certain this hurricane was caused by climate change”

I mean

“Without climate change it would not have happened”

- something impossible to prove.

Probabilistic version:

before climate change, $P(\text{hurricane in October}) = p_1.$

after climate change, $P(\text{hurricane in October}) = p_2.$

We need to understand something of probability theory, but . . .

In a survey carried out by the Royal Statistical Society in 2011

a total of 97 UK MPs were asked this probability problem: if you spin a coin twice, what is the probability of getting two heads?

Only 38 of the 97 replied correctly, although 72 said they felt confident when dealing with numbers.

Challenge for scientists: increase our own understanding of probability and uncertainty, . . . and share it.

We need our *legislators* to understand probabilities.

Assessing responsibility

In any case, how do we measure (or even define what is meant by) the probability of extreme events under changing conditions?

Statistical interpretation of complex data is not easy to get right, and may take too long to allow adequate response.

Computer simulations of climate under different levels of CO₂ can be used to assess their impact; repeatedly running the models with varying parameters allows us to accumulate “statistical” evidence

... provided we accept the models. See

www.wcrp-climate.org/conference2011/documents/Stott.pdf

on probabilistic event attribution.

This may have legal implications: could Tuvalu, or European ski resorts, sue Exxon-Mobile or the US government?

Loops

Another feature of the denial promoted by the George C Marshall Institute, the Heartland Institute, and others: their remarkable success in getting the ear of government. Oreskes and Conway document how, repeatedly, when mainstream scientific bodies came to worrying conclusions about acid rain, or the danger of tobacco smoke, the US administration listened to the deniers.

Is this market fundamentalism? Is it a hangover from the Cold War? Is it because government is responding to the interests of large corporations?

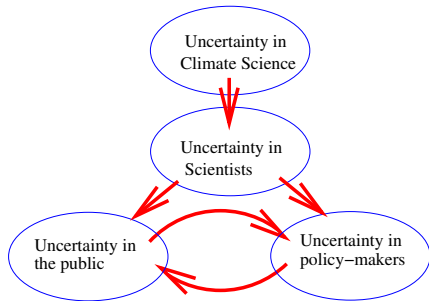
These interests may well be different from those of the public at large. Maximising shareholder value may be incompatible with Isaac Azimov's three laws of robotics

http://en.wikipedia.org/wiki/Three_Laws_of_Robotics

- especially the zero'th.

Dangerous loops

Do governments have other reasons to embrace denial? Party funding? Elections?



In our democracies, political parties compete for votes by offering better living standards. The threat from climate change lies over the electoral horizon. By accommodating denial, governments are able to justify their failure to take unpopular action - “we do not act because the case is not settled”.

They do not want to act because action to reduce emissions substantially and rapidly will cause hardship to voters, and to party donors, and therefore may lose them the next election.

“The green agenda costs jobs” - see e.g. recent speech of Owen Paterson, former Environment Secretary.

So uncertainty is a shield with which to defend a failure to act, though this failure may well have other motives.

The influence loop shown at the bottom of the diagram is particularly dangerous. It suits both sides to deny the reality of climate change, and each reinforces the beliefs of the other.

Conspiracy Theories?

In the climate debate, both sides accuse the other of “conspiracy”.

“Climate change is just a hoax to get funding for scientists”

“The fossil fuel industry funds climate denial in order to safeguard the worth of its assets”.

The science is so complex, and involves so many fields, that few can understand it enough to make a judgement purely on the basis of the arguments (and not of the individuals making them).

Science, and policy, belong to large organisations, of which it is easy to be suspicious. Is it money or old Cold War hatreds that fuel the controversy?

Reasons to be Cheerful?

Mary Lou Zeeman invited staff in Cornell University to participate in an interdisciplinary module on Climate Change. She told each one : spend at least $2/3$ of your lecture being optimistic.

In our desire to convince doubters, we emphasise the danger and warn that there is no time to lose: soon it will be too late!

This may lead to cynicism and despair rather than urgency and resolve, and to a search for individual solutions rather than collective action.

To prevent uncertainty from causing damaging delays to essential action, we need knowledge and understanding

- ▶ of climate science
- ▶ of probability and statistics
- ▶ of the psychology, sociology, politics, economics and law involved in policy choices.

Welcome to IL006 !