From words to action

The disturbing predictions about global warming in the latest report from the Intergovernmental Panel on Climate Change (IPCC) mark a turning point. That’s not because of the figures themselves, which are largely in line with previous IPCC forecasts, but because the science behind them is now certain enough to make a serious response from policymakers almost inevitable. The debate is no longer about whether we can believe the numbers, but what we should do about them.

And so the report, released in Paris on 2 February (see ‘Behind the scenes’), may be the harbinger of another change. As the debate evolves, say climate researchers, so must the IPCC. Many now feel that its weighty structure — the latest report has more than 1,200 authors and reviewers — is no longer useful. If the panel is to guide policymakers in the future, it must slim down, and become more focused on producing data that politicians can use. “The IPCC needs a complete overhaul,” says Mike Hulme, director of the Tyndall Centre for Climate Change Research in Norwich, UK. “The structure and process are past their sell-by dates.”

This might seem contrary, given the panel’s enormous influence. But the proposed shift is partly a recognition of the success that climate scientists and the IPCC have had in revealing the scale of the problem. The latest report, the panel’s fourth, is peppered with predictions that recent observational data have also reinforced. “The scientific case for global warming is overwhelming. So what next for the IPCC? Helping policymakers decide what to do now may require radical reform, reports Jim Giles.”

Some of that confidence comes from the accuracy of previous IPCC predictions, such as estimates made from 1990 onwards, that global temperatures would rise by between 0.15 °C and 0.3 °C per decade. Temperatures have climbed steadily since: the ten hottest years on record all postdate 1990, and the rate of warming, 0.2 °C per decade, fits the initial prediction.

More sophisticated models and mounting observational data have also reinforced simulations of future climate. For example, the new report is the first to go into detail on how warming will affect the carbon cycle. The previous report, released in 2001, was unable to say whether rising temperatures would further increase atmospheric carbon levels by speeding up the decay of organic matter in soils, or cut levels by promoting plant growth. It’s now clear that the former effect dominates, says Peter Cox, a climate modeller and IPCC author based at the University of Exeter, UK. “All the models give positive feedback.”

The report is the first to give a best estimate — 3 °C — of ‘climate sensitivity’: the global mean temperature rise resulting from a doubling of carbon dioxide levels. The range of possible values has also been tightened, to 2.0–4.5 °C. This feeds into predictions of the temperature increase over this century, which is now given as 1.1–6.4 °C, compared with 1.4–5.8 °C last time. Where we end up on that scale will depend mostly on how much fossil fuel the world burns.

“Behind the scenes”

With the world’s media ready to leap on the report’s long-awaited conclusions, deciding the final wording of its summary was a sensitive process. After climate scientists completed a draft document last year (see Nature 441, 6–7; 2006), political representatives spent the Paris meeting negotiating the summary line by line, with researchers in attendance to make sure vested interests didn’t distort the science. The consensus from the scientists is that the process worked well, with the final summary a fair representation of their conclusions. The United States has in the past been accused of seeking to play down some of the more alarming conclusions, but no such charges were levelled on this occasion. There were a couple of sticking points. The Chinese and Saudi Arabian delegates annoyed scientists by insisting that a line stating that man-made warming “is at least five times greater than that due to solar output changes” was cut. But the data remain in the report.

Another hot topic was the contribution that melting polar ice makes to sea level rise. The publication of new papers on the subject, one on the day before the report itself (see page 580), prolonged the debate. But some researchers still felt the new results weren’t properly considered, and that the final figures, which predict a sea-level rise of 0.18–0.59 metres by 2100, are too conservative. J.G.
“This may be remembered as the day the question mark was removed from whether human activity has anything to do with climate change.”
Achim Steiner, head of the United Nations Environment Programme

“Now is not the time for half measures. It is the time for a revolution.”
French president Jacques Chirac

“The question is, what can we do now? There’s very little we can do about arresting the process.”
Anote Tong, president of the Pacific island nation of Kiribati

“This should compel all of us towards action rather than the paralysis of fear.”
Martin Rees, president of the United Kingdom’s Royal Society

“All of my colleagues and I are convinced that humans cause global warming!”
Headline from China’s Xinhua news agency

“Let's be realistic. You can only run power stations in a modern Western economy on fossil fuel, or, in time, nuclear power.”
Australian prime minister John Howard, whose country has not ratified the Kyoto protocol

“Those who continue to ignore the threat will be doing the greatest disservice imaginable to current and future generations.”
Marthinus van Schalkwyk, environmental affairs minister for South Africa
What we don't know about climate change

The 4th Assessment Report from the Intergovernmental Panel on Climate Change (IPCC) has a finely calibrated lexicon of certainty. "Virtually certain", it blares when it assigns a 99% probability to hot days getting hotter and more frequent. "Very likely", or more than 90% probable, are heavier rains. And so on down the list — including the wishy-washy "more likely than not" when assigning a greater than 50% probability, such as the chance that human activities are affecting the intensity of hurricanes.

Such care is crucial in a field that is still, in some areas, shot through with uncertainty. The IPCC has gone far in tightening up some key scientific unknowns about climate change (see page 578), but many still remain. Some conclusions — such as the effect on particular regions of the world, or exactly how much sea level will rise — remain more uncertain than others. This means that there's plenty of work left for the climate scientists on whom the IPCC process depends.

Perhaps most critically, researchers know relatively little about feedback effects that might enhance — or weaken — the pace and effects of climate change. The complex flow of carbon between soils, plants, the oceans and the atmosphere is still being pinned down by large-scale climate experiments. Some experts predict that, in a warmer world, ecosystems that are currently sinks for carbon, such as the Arctic tundra, may turn into carbon sources. But no one can yet accurately predict how this might pan out, and feedbacks among land and air could end up putting far more carbon dioxide into the atmosphere than currently forecast.

Other big unknowns are the effects of the take-up of carbon dioxide by the oceans, which removes the gas from the atmosphere and locks it away in the calcium carbonate of the shells and skeletons of marine organisms. Higher levels of atmospheric carbon dioxide are expected to make the seas more acidic and slow down the rate of calcification, ultimately reducing the ocean's ability to absorb more carbon dioxide. But precisely how the biology of marine creatures would play into that effect is unknown. Nor is it known how changes in plankton composition and coral reefs, for example, might affect carbon dioxide concentrations.

Pinning down biological feedbacks will be critical for future reports, says Richard Bellerby, a chemical oceanographer at the Bjerknes Center for Climate Research in Bergen, Norway. "We're going blindly into the future," he says.

Another major source of uncertainty — and of debate at the Paris meeting where the IPCC report was finalized — is the rise in sea level. In 2001, the IPCC predicted a rise of between 9 and 88 millimetres by 2100, as a result of melting ice caps and the thermal expansion of the ocean. This time around, the group has narrowed that range to between 19 and 58 centimetres. But some scientists say that this is an underestimate.

Stefan Rahmstorf, an oceanographer at the Potsdam Institute of Climate Impact Research in Germany, believes, for instance, that global sea level could rise by much more than that. In a paper published online the day
before the IPCC report's release, Rahmstorf and his colleagues argue that sea-level rises will be close to the worst-case predictions of climate models (S. Rahmstorf et al. Science doi:10.1126/science.1136843; 2007). "If anything, the IPCC has been conservative," he says.

Key sticking points include the inability of global climate models to produce the amount of sea-level rise observed over the past couple of decades and whether ice flow at the bases of glaciers is accelerating or not. How volatile Antarctic and Greenland glaciers might become in a warmer world is therefore pretty much guesswork.

For the first time, the IPCC report predicts how changing climate might affect particular regions of the world. But these forecasts are only in their infancy, modellers warn. For some areas, models predict specific and well-understood effects, such as hotter summers in Spain and smaller snowpacks (the accumulation of snow each season) in the Rocky Mountains in the United States. But improved analyses that incorporate clouds, snow and ice into the models must be developed if regional predictions are to become more accurate, says Rasmus Benestad, a climate modeller at the Norwegian Meteorological Institute in Oslo.

Extreme weather is another example of the remaining uncertainties. Climate researchers believe that storms and heavy rainfall will become more frequent as the planet warms. But pinning down where and when that might happen is not so simple.

In the tropics, rising sea-surface temperatures can be linked in a relatively straightforward manner to storm formation, and the case for more intense storms seems more or less settled. But in the mid-latitudes, where atmospheric processes are more complex, some climate models predict more storms whereas others do not.

Improving the models, experts say, requires better data. Gaps and errors in observations are attributable to many causes: snowfall gauges that ice up, oceanographic floats that get lost, and changeovers in satellites that throw off carefully calibrated trends, to name but a few. Cloud and storm records urgently need to be reprocessed using uniform techniques, says Kevin Trenberth, a senior scientist at the National Center for Atmospheric Research in Boulder, Colorado, and coordinating lead author of the report's chapter on surface and atmospheric change.

"The IPCC report is a consensus report, and one that develops over nearly three years," he says. "This means that it is not the leading — or bleeding — edge of the science."
Reports by the Intergovernmental Panel on Climate Change (IPCC) are held out as a model of consensus science, with thousands of international scientists coming together to present the most detailed look ever at a single scientific topic. Yet a consensus among most of the world’s researchers does not mean that everybody agrees.

“I am one of the 2,000 with their names on [the assessment], but don’t sign me up for that catastrophic view of climate change,” says John Christy, a climatologist at the University of Alabama in Huntsville and a contributing author to the report.

And outside the IPCC process there remains a dwindling band of climate sceptics, those who argue that global warming is not linked to human activity and that it would be rash to take drastic action to cut carbon emissions. The focus of these arguments, however, has shifted noticeably since the previous IPCC report was published six years ago. Many of the scientific uncertainties the sceptics have seized on are no more.

“Their argument continues to shift,” says Naomi Oreskes, a geologist and science historian at the University of California, San Diego. “That makes it clear that the issue is not the science.”

Last year’s review on climate change by Nicholas Stern, a senior British civil servant and former vice-president of the World Bank, was conceived as the definitive statement on the cost of climate change. So far, though, its legacy has been a debate among economists that has as much to do with ethics as money.

“The review and the critiques that have followed it highlight that many of the important questions boil down to what we choose to value,” says Roger Pielke Jr, an expert in climate-change policy at the University of Colorado, Boulder. Perhaps the most vexing question is how current generations should value their successors’ welfare.

Nicholas Stern has been criticized for overestimating the current value of future generations’ welfare.
The change cut the optimal rate of emissions reduction by 2050 from 25% to 14%. Stern retorts that a pure-time discount rate of 1% is "outrageously high", as it values things happening in 100 years as only one-third as important as things happening now.

Economist Partha Dasgupta of the University of Cambridge, UK, although largely supportive of Stern’s conclusions, takes issue with the way that the report’s egalitarian approach to different generations — valuing their well-being equally — is not carried through to its discussion of inequalities in today’s world. Stern’s calculations, Dasgupta argues, underestimate the degree to which a given dollar benefit a poor person more than a rich one.

Such arguments may seem like a good way to stall progress, but many, including Stern, value the attention to ethics. "How important a problem climate change is and what society should do about it is all about subjective judgements," says Mike Hulme, director of the Tyndall Centre for Climate Change Research in Norwich, UK.

However, the focus on the discount rate’s effects on the estimated cost of damage has partly overshadowed the Stern report’s second striking conclusion — that the worst effects of climate change can be avoided for at most 4% of GDP.

The Stern review used a very low pure-time discount rate, treating current and future generations equally. But there is little consensus on this among economists. Some, such as William Nordhaus of Yale University in New Haven, Connecticut, find low rates hard to accept, adding that the way markets work supports this position.

Stern’s conclusion "depends decisively on the assumption of a near-zero discount rate", Nordhaus wrote in a critique posted on his website in November. Nordhaus recalculated Stern’s assessment of the optimal rate at which emissions should be reduced using a pure-time discount rate of 3% that declines to 1% in 300 years, rather than the 0.1% rate used in the Stern review. The change cut the optimal rate of global temperatures. And solar variability — natural fluctuations in the amount of the Sun’s radiation reaching Earth — does affect climate, but to a far smaller extent than the burning of fossil fuels.

With less to argue about on the scientific front, climate sceptics have been turning their attention to the economics of adapting to a changing climate.

Christy believes that fostering innovation is the way to decrease reliance on fossil fuels. "We’re going to look back in a century and say ‘wasn’t it quaint, we burned carbon,'" he says. "I’m very optimistic; I see the wealth of the Earth continuing to rise. But suppressing energy is not the way. Keep energy inexpensive and affordable and allow people to do research.”

As for the Kyoto Protocol on climate change, the international agreement to reduce carbon emissions, Christy calls it “sinister”.

Economic arguments also play a strong role in the views of sceptic Patrick Michaels, an environmental scientist at the University of Virginia who argues that taking action on climate change can have dire economic consequences. He sees the current US move towards embracing biofuel as causing corn prices to surge, triggering inflation and leaving many poor people, particularly in Mexico, struggling to buy food. “Small changes in policy can lead to a recession,” he says.

It remains to be seen whether these arguments will gain much traction. Alan Thorpe of Britain’s Natural Environment Research Council, which hosted an online debate to canvass climate sceptics on their views, says that such views range from lazy to devious.

“T think there is a degree to which there is mischievous use of scepticism,” he says. “Sceptics want to accuse scientific society of wanting a particular policy outcome, but actual policy is up to governments.”

Michael Hopkin

The Sun has set on most scientific objections to the evidence for global warming.