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Model of change: Ireland's vulnerable climate

NOBODY can have missed the sequence of worrying pronouncements issued by the IPCC, the Intergovernmental Panel for Climate Change, over the past year.

Every five years or so, this international body evaluates all the scientific research on climate change and produces an assessment report. The fourth such report goes significantly farther than previous ones, indicating that there is no longer any real doubt about climate change and about the cause, which is us.

It was a Carlow-man, John Tyndall, who first realised how important water and carbon dioxide (CO2) are in determining the temperature at the surface of the earth. These constituents capture the radiation coming from the Earth, acting like a blanket that keeps us warm.

This is what we now call the greenhouse effect.

But we have been increasing the CO2 by burning oil and coal so that the system is becoming over-heated.

How does IPCC reach its conclusions?

The best way to anticipate future changes in the Earth's climate is to simulate it using computer programs called climate models. The basis of these models is the system of physical laws that govern the behaviour and

Local climate models give insight into future risks for Irish life but the data is imperfect, writes Peter Lynch

evolution of the atmosphere and ocean. The fundamental principles are the conservation laws for mass and energy and Newton's laws of motion.

They are expressed in terms of mathematical equations which can be solved using powerful computers.

We can simulate the current climate well by setting factors like the level of CO2 at their present level. By changing the level of CO2 in the model and running another simulation, we can estimate the likely climate under future conditions.

Model results differ in details, but all show significant warming resulting from elevated CO2. This allows IPCC to be confident in its predictions of temperature rises over the coming years.

Global models simulate the entire atmosphere-ocean system, but have to omit many fine details which are important locally. A regional climate model, nested within the global model, can be used to represent this detail.

We have been using such a regional model in the C4I Project.

This is a collaboration between the climate group in Met Eireann and the UCD Meteorology & Climate Centre.

The model, called HIRLAM, (High Resolution Limited Area Model) gives us valuable insight into future climate change in Ireland.

What does HIRLAM say? Mean temperatures will rise over the next 50 years by about two degrees, with warming being greater inland than near the coast.

Both summers and winters will be warmer. Winters will be wetter and summers drier than now, by between 10% and 20% in each case.

River flow will decrease, with summer levels down 50% in some catchments. Extreme weather events are likely to be more frequent. Many more results are available at www.c4i.ie.

Can we trust these predictions?

Only up to a point: we know that there are large uncertainties in our models, and we have to treat the results with caution. One way of gaining more confidence is to run ensembles of predictions. We simulate the climate under a range of differing conditions and examine the spread of behaviours.

The ensemble approach allows us to estimate the probabilities of various possible future climate scenarios. This work is under way.

The best weather prediction model is that of the European Centre for Medium-Range Weather Prediction (ECMWF). In a new international programme called EC-Earth, we are planning to develop this into the best global climate model. UCD, Met Eireann and ICHEC (the Irish Centre for High-End Computing) are participating in the EC-Earth venture, and a recent meeting of the group at UCD was opened by John Gormley, Environment Minister, who stressed the importance of this work for Ireland.

However much we refine our models, there is the real risk that we misrepresent or completely omit crucial factors. As a result, there is a danger that we may fail to anticipate changes in the climate.

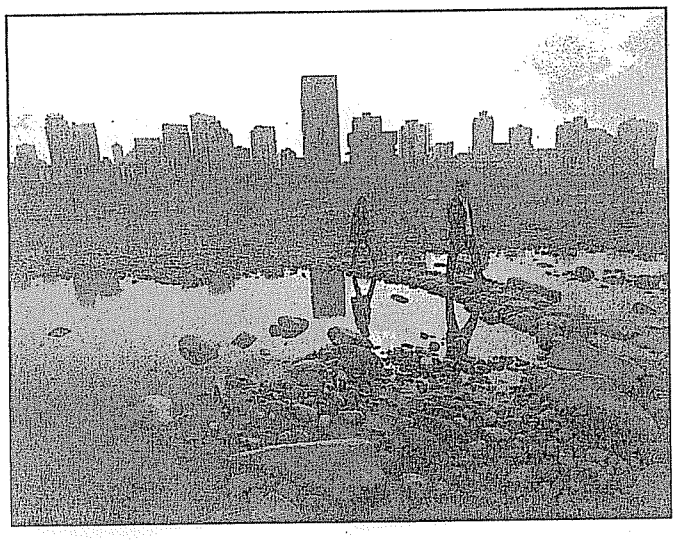
An example of an event that was not foreseen is the ozone hole in the Antarctic stratosphere.

This depends on complicated chemical reactions occurring on the surface of ice crystals. Nobody anticipated this phenomenon.

Many climate scientists are concerned about abrupt climate change.

They speak of tipping points, where the pattern of climate changes dramatically and without warning. They have grounds for their concern, since paleo-climate records show that sudden changes have occurred in the past.

As we continue to produce more CO2, we are pushing the atmosphere far beyond any state found in the historic record. There is an unquantifiable risk of catastrophic climate change. We need to increase our research effort to better understand the system. And we need to decrease the level of CO2 that we are pumping into the air.



Climate models tell us that weather events like the drought period in 2007 in the Chongqing Municipality, China, are likely to be more frequent.

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Peter Lynch is Met Eireann Professor of Meteorology at UCD. His main research interests are in dynamic meteorology, numerical weather prediction and climate modelling. He is the author of The Emergence of Numerical Weather Prediction: Richardson's Dream.