Climate Change Research in Met Éireann

MET éireann

Met Éireann plays a key role in analyzing the Irish climate. Its observational records, extending back more than a century at some sites, are essential for establishing a baseline to measure recent climate trends and to provide a context for forecasts of future change. The data are also vital for validating the numerical models used to predict the future climate.

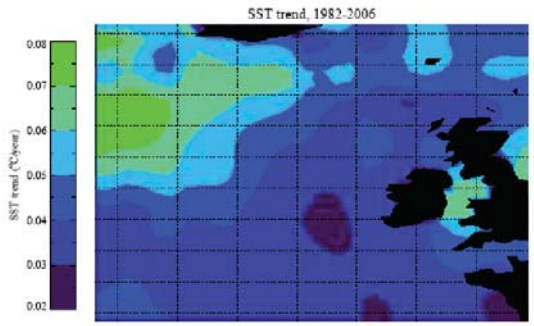
Met Éireann takes great care to ensure that its observational records are, as far as possible, free from error or spurious influences that might arise from changes in instrumentation or reporting practices. Its extensive archives are the authoritative source of climate information in Ireland, a national resource that is widely used in research.

In 2003, Met Éireann initiated a climate modelling project called C4I (Community Climate Change Consortium for Ireland - see http://www.c4i.ie) to provide regional information on future climate change and its likely impacts. The project builds on the modelling expertise that Met Éireann employs to produce its operational weather forecasts. Technically, it dynamically downscales the relatively coarse-grained information produced by global models to tease out the finer details over a smaller area. This approach - regional climate dynamic modelling - is unique in Ireland. The work is done in collaboration with the Meteorology and Climate Center at UCD, and more recently, with the Irish Center for High-End Computing (ICHEC).

While the core activity of C4I has been to produce an extensive archive of future climate scenarios for Ireland, it has also turned its attention to wider issues related to the climate. A flavor of the work is described below.

Influence of the Atlantic

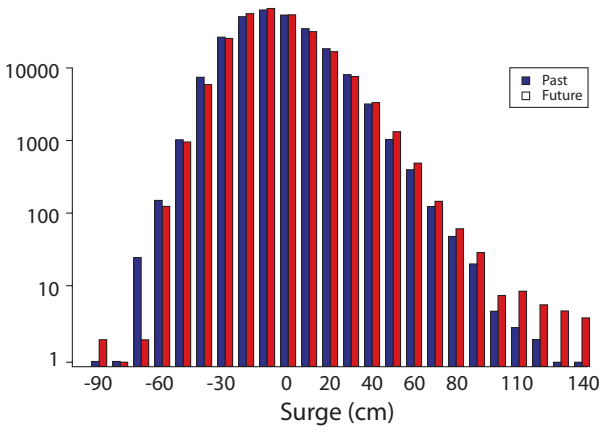
Most of the heat energy associated with global warming has found its way into the oceans. The expansion of the water in response to the heat, and the influx of fresh water due to the melting of land-based ice and snow contribute in roughly equal measure to a global rising of sea levels (changes in salinity also play a minor part). Globally, the rise equates to about 1.7 mm/year in the 20th century, but there is strong evidence that since 1993 the rate of rise has accelerated to about 3 mm/year. There are large regional variations.



Trends in sea surface temperature in the northeast Atlantic since 1982 from the Advanced Very High Resolution Radiometer on board the NOAA satellite series.

Estimates of sea level rise from satellite observations around Ireland are consistent with the global picture: increases of 2.3 to 4.7 mm/year since 1993. At current rates of change, mean sea levels in Dublin, Sligo Bay and Slea Head will be 25, 44 and 40 cm respectively, above present day levels by the end of the century. These figures take into account vertical land movement due to post-glacial isostatic adjustment. They are also consistent with the 2007 IPCC report which suggests rises in the range of 22 to 44 cm, although these figures probably do not reflect the full impact from melting ice sheets.

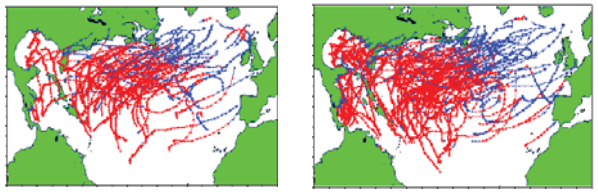
However, this is not the full story. Global warming will increase the frequency of severe weather (e.g. storms). To assess the impact on storm surges around Irish coastal areas, C4I has used generated climate scenario data to run an ocean model for two 30-year periods (1961-1990; 2031-2060). The results indicate that in western areas there will be a significant increase in the extreme surge events - heights exceeding 100 cm. Adding on the effects of sea level rise, the vulnerability to flooding is clear. This study quantifies the risks for different regions.



Histogram distribution of surge events for Galway Bay for the current (1961-1990) and future (2031-2060) climate. Results are available for all Irish coastal waters and the Irish Sea.

Storms

Warming seas will provide more moisture to fuel the development of storms and this is expected to increase the number of severe hurricanes in the Atlantic. This is consistent with what has been observed over the past decade, although longer records show a good deal of variability. Hurricanes may not directly affect Ireland, but the remnants of these systems (extratropical cyclones) occasionally reach Europe and can be very destructive, with severe winds or heavy rainfall. To quantify the direct effects of rising sea temperatures C4I has carried out idealized climate simulations with sea temperatures artificially raised by 1°C. The results suggest that higher sea temperatures lead to a higher count of cyclones over most parts of the North Atlantic, at least during the extended hurricane season. In particular, the count of very intense cyclones increases strongly (e.g. a 4-fold increase in the number of extratropical cyclones with wind speeds of at least 66 knots). The results are confirmed in simulations of the future climate (2085-2100).



Tracking the storms - tropical (red) turning to extratropical (blue) - for the period May to December 1985-2000. Left: standard climate. Right: with increased sea surface temperature. Such experiments help to quantify the risks associated with climate change.

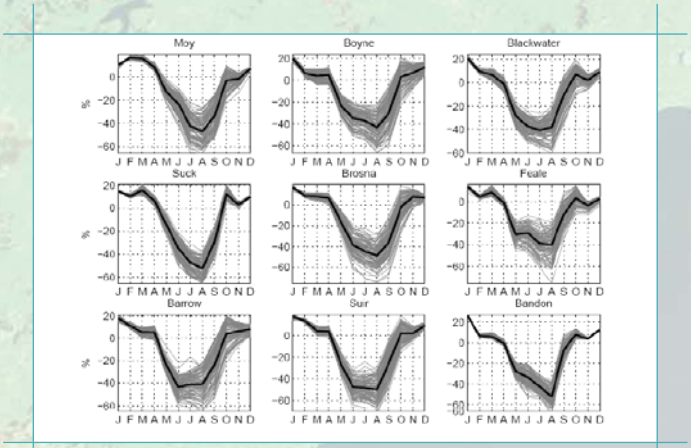
Tackling uncertainty

Climate modelling is not an exact science. Forecasts, particularly those for the second half of the current century, are strongly dependent on the levels of greenhouse gas emissions ('emission scenarios') in the coming decades. The computer models are also not perfect, but continue to improve and are gradually embracing the numerous interlocking processes that make up the real climate system. Overall, there is still a good deal of uncertainty, particularly for rainfall, regarding the details of climate change and its impacts at a local level. To quantify this uncertainty C4I has adopted an 'ensemble' approach: running many simulations of the future climate using different emission scenarios and different global model outputs. This type of approach is essential in critical applications involving risk assessment.

Mean precipitation change (2021-2060 compared with 1961-2000) for each month (left to right) from an ensemble of 4 simulations. Green areas are wetter, pink areas drier.

River Flooding

Nine Irish catchments have been studied using data produced by the C4I climate simulations, to investigate the hydrological impacts associated with climate change. Results suggest that increased winter precipitation in the future will lead to a rise in winter stream flow, while the combination of increased temperature and decreased precipitation will cause a reduction in summer stream flow. These changes have implications for water supply management and design. Increased winter flows, coupled with the predicted increase in extreme precipitation events, will lead to an elevated risk of flooding. This is particularly significant in the southwest of the country, and those catchments which have the fastest response to storm events. The decrease in summer stream flow will impact on water availability, water quality, fisheries and recreational water use.



Percentage change in monthly mean daily river flow due to climate change (2021-2060 compared with 1961-2000) for a typical emission scenario, for different river catchments. Uncertainty in the hydrological model is revealed by running many 'ensemble' simulations, shown in grey, with the ensemble mean shown as a black line.

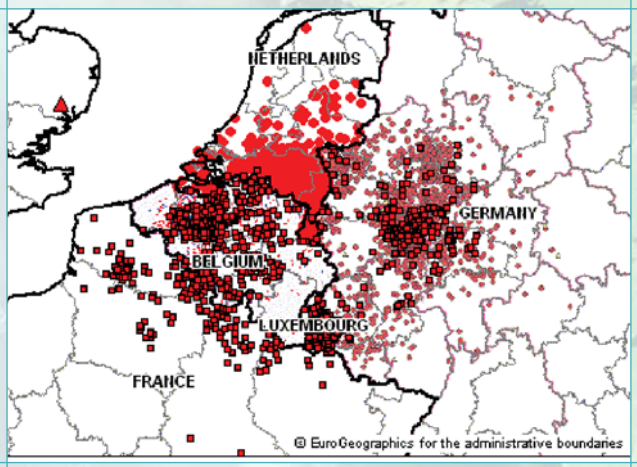
Health issues

The stratospheric ozone, which partially filters the damaging components (e.g. UV-B) of sunshine that are associated with skin cancers, is likely to be affected by climate change. Concentrations of ozone have been declining at a rate of 6% per decade from 1980 to 2000, due to the anthropogenic release of chlorofluorocarbon (CFC), leading to increased UV-B radiation. Levels are expected to recover at a rate of 1 to 2% per decade from 2000 to 2020, following the gradual reduction in the emission of CFC. The effects of climate change have been estimated by C4I, comparing the period 2021-2060 to the reference period 1961-2000.

The results of this study indicate that ozone recovery might happen more slowly than expected. It shows that circulation changes in a future climate can have a significant impact on ozone concentrations. Even though the net effect is likely to be an ozone recovery, the risk of skin cancer in Ireland will not necessarily decrease; the benefits of the recovery may be offset by increased exposure in outdoor activities, prompted by a warmer climate.

Agriculture

The impact of climate change on agriculture will be substantial. For example, current pests and diseases in Ireland are suited to a warm, wet summer and a mild winter; a changing climate will affect this balance. There will be a tendency for pests and diseases (e.g. Bluetongue) that are currently found in southern parts of continental Europe to move northwards towards Ireland. C4I is currently using its climate simulation archives to estimate the future risks. Similarly, the impacts on the growing of crops are being investigated.



Bluetongue outbreaks in the Netherlands, Belgium, Germany and France February - August 2007. Climate change will influence future outbreaks.

Economic aspects

The influence of climate change on heating and cooling energy demand in Ireland has been studied using a small ensemble of regional climate model simulations. A clear trend of decreasing heating energy demand is predicted for the rest of this century in Ireland. The results from the simulations suggest major savings in winter and spring heating energy: 5-10% for the period 2021-2060 and 14-20% for 2061-2100, compared to the control period 1961-2000.

On the whole, the picture suggests that in Ireland a 10±3% decrease in heating degree days is predicted for 2021-2060 and a 22±3% decrease for 2061-2100 compared to 1961-2000.

The increase in summer cooling degree days, from a low value in the current climate, may intensify a weak demand for air conditioning towards the end of this century. However, the main influence of a warming climate will be reflected in a decrease in energy requirements for commercial and domestic heating in Ireland.

International links and future work

Met Éireann is a partner in the ENSEMBLES project that is funded under the European Commission's 6th Framework Programme. The project is focused on quantifying and reducing the uncertainty in modelling the European climate, using an ensemble approach with both global and regional climate models. As part of our contribution we have run 100-year climate simulations covering the whole of Europe.

More recently, Met Eireann has become a partner in the EC-EARTH project. EC-EARTH aims to develop a new state-of-the-art Earth System Model that will accurately describe the various feedbacks between the climate components. Ultimately, this will enable us to provide more accurate forecasts of the Irish climate.

The uncertainty inherent in climate predictions will require ongoing scientific research. Met Éireann, in support of the National Climate Change Strategy (2007), will continue to be engaged in this work ensuring that it delivers practical advice on climate change for planners and developers in Ireland.

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