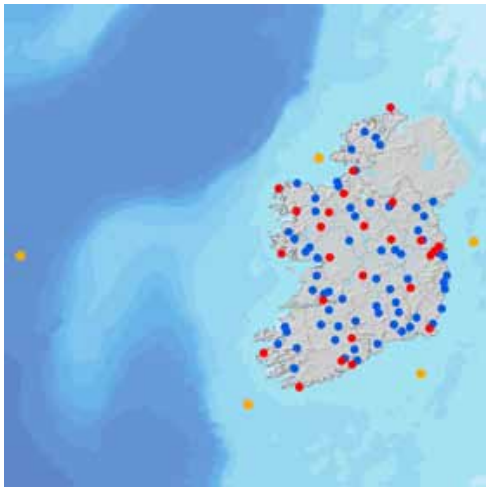
2.1 Surface Air Temperature

Séamus Walsh and Ned Dwyer

Surface air temperature is a key (and perhaps the most familiar) climate variable. More than 100 years of continuous instrumental observations exist in Ireland. The global mean surface temperature has increased by approximately 0.74°C over the last century, and most of this increase is very likely due to the observed increase in greenhouse gas emissions caused by human activities. Globally, over recent decades there has been a significant decrease in cold days and cold nights and a significant increase in warm days and nights and heat waves. Such changes are having severe impacts on the environment, biodiversity and human society.

Photo: © Ned Dwyer



Map 2.1. Location of surface air temperature observation stations.

Measurements

Surface air temperature in Ireland is measured at the 25 synoptic (red) and numerous climatological (blue) weather stations and also at the marine weather buoys (orange). Readings at automated synoptic stations are made every minute and at staffed stations every hour on the hour; at climatological stations, readings of maximum and minimum temperatures over the previous 24 hours are made once a day at 0900 UTC (Coordinated Universal Time). Data from synoptic and climatological stations are available in digital format from 1961. Surface air temperature is measured every hour on the marine weather buoys, the first of which was deployed in 2000.

'In Ireland the annual average surface air temperature has increased by approximately 0.8°C over the last 110 years.'

Time-series and Trends

An average national surface air temperature series for Ireland has been derived using data from five long-term stations, namely Valentia, Malin Head, Armagh, Birr[2] and the Phoenix Park. Figure 2.1 shows the mean annual observed temperatures (black dots) along with simple statistical fits to the data. The left-hand axis indicates anomalies (the difference between the mean annual temperature and the 1961 to 1990 normal or reference mean value) and the right-hand axis the mean annual temperatures for the period 1900 to 2011. Six of the top ten warmest years on record have occurred since 1990. The blue curve shows the 11-year moving averages. A simple linear trend line[3] (red) has been fitted to the annual anomaly values. This indicates that the annual average surface air temperature has increased by approximately 0.8°C over the last 110 years.

The temperature has varied over the period, with colder than normal episodes in the early part of the twentieth century and some cold years in the 1960s and '70s. Higher temperatures were recorded from the early 1930s to 1960 and from the late 1980s to the present. The overall trend is upwards and consistent with global patterns of change. It is interesting to note that although 2010 was a cold year by the standards of the previous two decades, it was not unprecedented in terms of the overall record, and indeed would have been typical of temperatures in the early part of the twentieth century.

An analysis of seasonal temperature difference, based on gridded data averaged over the area of Ireland, shows a rise in temperatures in all seasons. Figure 2.2 shows that both winter (December–February) and summer (June–August) minimum temperatures have tended to be higher than the 1961–1990 average, in particular over the last 20 years, although the anomalously cold winter of 2010 is evident.

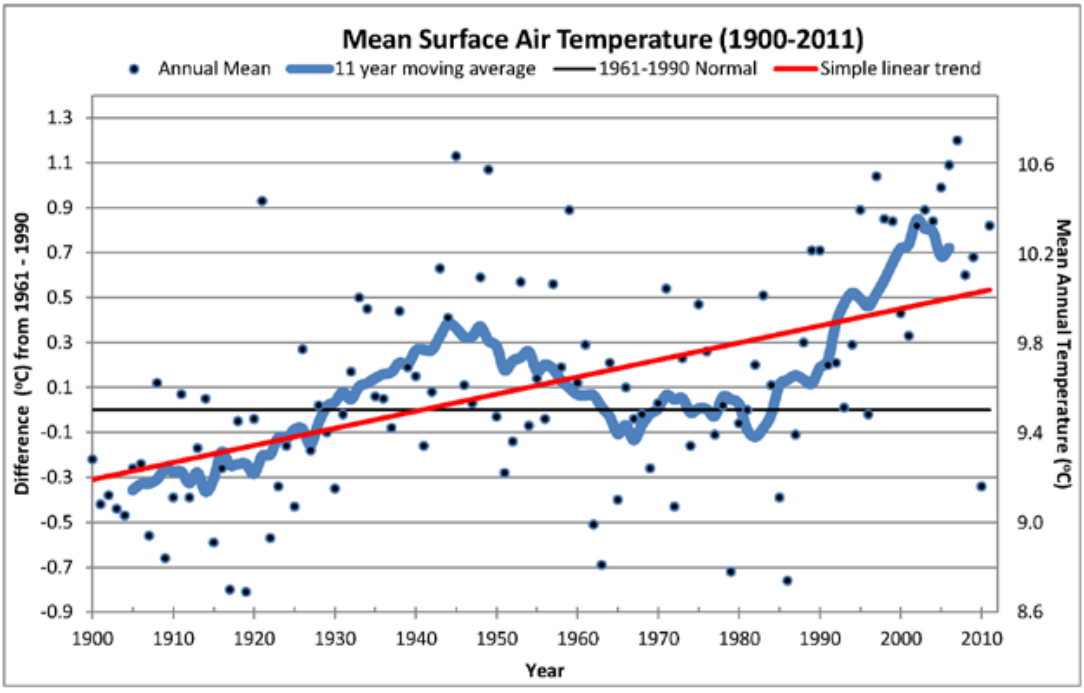


Figure 2.1. Annual mean surface air temperature (1900–2011).

2 The Station at Birr closed in October 2009; from late 2009 weighted data from the nearby TUSCON station at Gurteen were used.

3 A linear trend line is a basic but widely used statistical measure, however the length of the period used can change the trend.

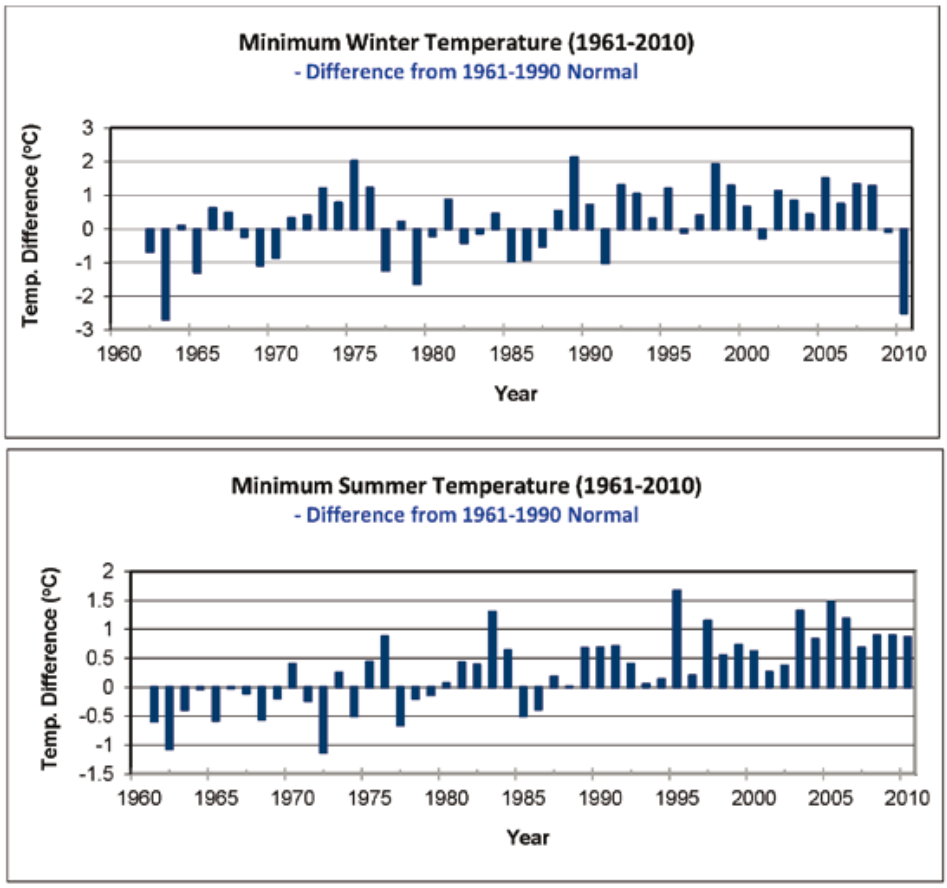


Figure 2.2. Winter (top) and summer (bottom) minimum surface temperature anomalies (1961–2010).

'The number of warm days has increased and the number of frost days has decreased over the last 50 years.'

Climate Change Indicators

The World Climate Research Programme has defined a range of climate change indicators to enable uniform comparison of these variables. In the case of temperature the indices include number of frost and ice days and days with temperatures above or below a certain threshold. Information on frost days, for example, is important to plan for road-gritting and heating requirements. Warm periods can have health implications, put pressure on water resources and increase tourism in certain areas. Trend maps have been calculated for the indicators from individual station records. Figure 2.3 shows that in the period 1961 to 2010 there has been an increase in the number of warm days (those with temperatures over 20°C), and a decrease in the number of frost days (those with temperatures below 0°C). This is in line with observations across Western Europe.

'Resources are required to produce homogenous temperature time-series and to collate and digitise paper records.'

Maintaining the Observations

The network of synoptic and climatological stations operated by Met Éireann needs to be maintained and further developed to ensure the future of long-term representative temperature measurements. The Irish Marine Weather Buoy Network deployment is the result of collaboration between the Marine Institute, Met Éireann, the UK Met Office and the Irish Department of Transport. The Marine Institute maintains the

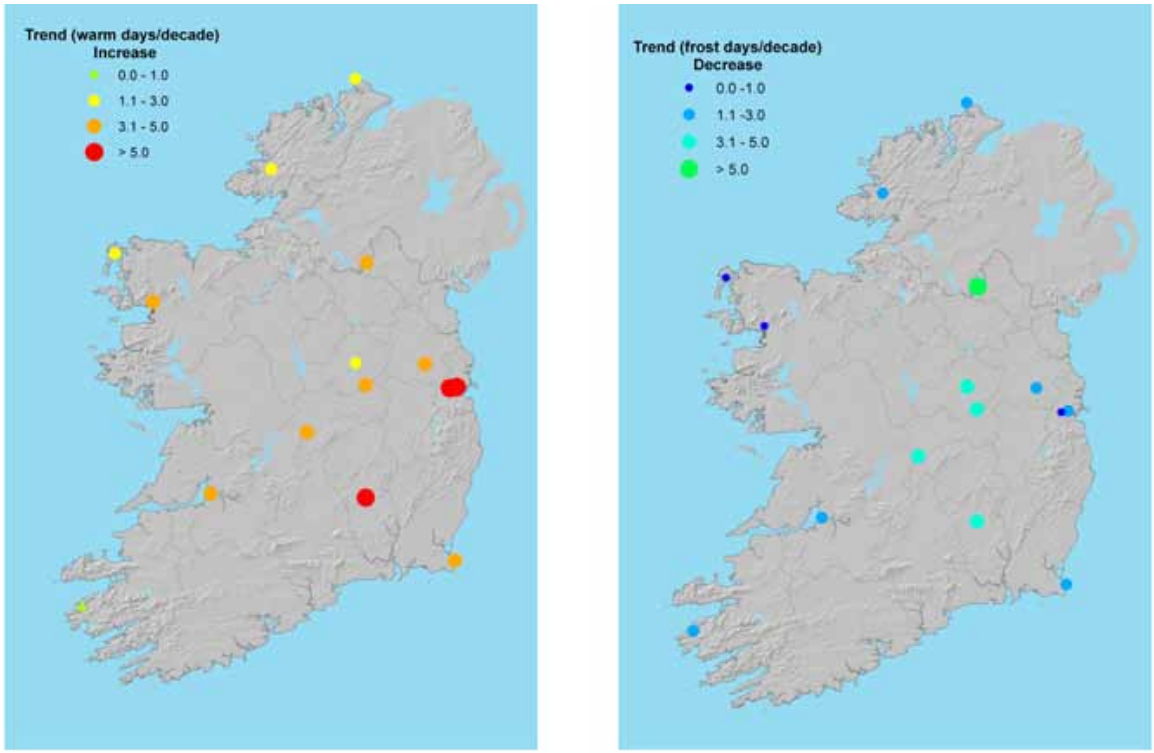


Figure 2.3. Trend in number of warm days per decade[4] (left) and number of frost days per decade[4] (right) (1961–2010).

Buoy Network hardware which is funded under a Memorandum of Understanding with the Irish Department of Transport while Met Éireann monitors the quality of the observational data. Difficulties can arise with time-series because of inhomogeneities due to changes in instrumentation, observer, location and times of observation and new building and tree growth in the vicinity of a station. Resources are required to produce homogenous temperature time-series and to collate and digitise paper records, including station metadata.

4 This represents the increase/decrease in number of days per year averaged over a decade.

Further Information and Data Sources

McElwain L. and Sweeney, J. (2007) *Key Meteorological Indicators of Climate Change in Ireland*. ERC Report 6, Environmental Protection Agency, Johnstown Castle Estate, Co. Wexford, Ireland, pp. 40: http://www.epa.ie/downloads/pubs/research/climate/name,23305,en.html

Information on air temperature in Ireland: http://www.met.ie/climate/temperature.asp

European project on climate data homogenisation methods: COST Action ES0601 Advances in homogenisation methods of climate series: http://www.homogenisation.org/v_02_15/

The World Climate Research Programme's expert team on climate change detection and indices: http://www.clivar.org/organization/etccdi/indices.php

Information on data availability: http://www.met.ie/climate/climate-data-information.asp

Long-term daily series of temperature and precipitation for a number of Irish stations are available from the European Climate Assessment & Dataset: http://eca.knmi.nl/

Information and observations from the Irish Marine Weather Buoy Network: http://www.met.ie/marine/marine_map.asp

Surface data from some Irish synoptic stations may be accessed at the US National Climate Data Centre: http://www7.ncdc.noaa.gov/CDO/cdo