



Understanding Ozone Levels in Ireland

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What did this research aim to address?

There is still uncertainty as to what is driving ozone pollution in Ireland, and if the causes are meteorological or national or transboundary emissions. This research aims to identify the contribution of ozone pollution from various international sources and the influence of meteorology via analysis of in situ measurements and advanced modelling techniques.

Ozone is a key player in atmospheric chemistry – a reactive, heavily oxidising gas that is produced naturally in the stratosphere and produced at surface level in the presence of sunlight and precursor pollutants. Ozone acts as a double agent, playing a beneficial role in the stratosphere by filtering damaging UV rays, yet acting as a harmful pollutant at surface level, causing negative human health effects, negatively affecting vegetation growth and acting as a climate-forcing greenhouse gas.

Ozone response to emission control is non-linear, governed by complex atmospheric chemistry; hence, its regulation poses a challenge for policymakers. Using long-term measurement records and advanced modelling tools, this research offers insights into the trends and drivers of past, present and future ozone pollution in Ireland.

What did this research find?

Counter-intuitively, ozone pollution is a clean-site problem in Ireland. Coastal and rural areas show higher ozone concentrations than urban areas owing to the prevalent effect of transboundary pollution and meteorological conditions that facilitate downward transport of ozone from the stratosphere in clean conditions and along the west coast of Ireland. Over the measurement record, urban areas show rising ozone trends due to declining NO_x levels in response to emission regulations.

Most breaches of World Health Organization air quality guidelines occur in springtime in rural and coastal areas, with air advected over the North Atlantic ocean contributing significantly to peak ozone levels.

European and North American efforts to reduce NO_x and volatile organic carbon emissions have lowered extreme ozone events but caused an increase in background levels in clean areas.

Methane is the dominant reactive carbon precursor to Irish surface ozone pollution, with increasing contributions from East Asia and biogenic sources, underscoring the global nature of ozone pollution and the importance of cooperation across borders to combat air pollution.

How can the research findings be used?

This research illustrates the need to further investigate ozone pollution by developing mechanistic modelling capacity to quantify sources and sinks of ozone over Ireland at high spatial resolution. Such modelling tools would enable policymakers to investigate the effect of national emissions on Irish ozone levels, inform a targeted policy response and allow for investigation of the impacts of a changing climate on future O₃ concentrations, trends and transport. Value could be added to existing modelling infrastructure developed in the Life Emerald project by advancing the assimilation of in situ and remote observations in an integrated data system, using machine learning techniques to identify correlations and trends in O₃ production and concentrations over timescales, for both long-term trends and immediate forecasts, to provide an early warning system for air quality specific to O₃ pollution.

This study highlights the significance of transboundary pollution for Irish ozone pollution levels, indicating the need for a shared transnational commitment to ozone mitigation as air pollution policies strive towards clean-air targets. This research also makes the case for Ireland to fully commit to the international Global Methane Pledge with the aim of reducing CH₄ concentrations.

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