Significant progress has been made since 2006 in reducing the emissions of many air pollutants from industry, stationary emissions, and the transport sector. Carbon emissions in the form of carbon dioxide have been reduced by 4% annually in Ireland since 2000, although they remain high compared to their 1990 levels. The reduction in emissions is largely due to a decrease in the use of coal, with the use of peat and oil falling by 3% and 20% respectively. Gas emissions have increased by 20% since 2000, primarily due to an increase in the use of gas for heating and cooking.

Looking into the most likely future pollution storylines, the IPCC AR5 Representative Concentration Pathway 6 (RCP6) is selected as the most likely development scenario for CO₂ emissions. This scenario leads to a radiative forcing of 6 Wm⁻² by 2050 and 8 Wm⁻² by 2100. The scenario is characterized by a global temperature rise of 1.8°C by 2050 and 2.3°C by 2100, with an increase in global mean sea level of 0.76 meters by 2100. The scenario is driven by a combination of mitigation and adaptation measures, with a reduction in global emissions of 80% by 2050 and 95% by 2100.

###REFERENCES

AEROSOLS AND AIR POLLUTION

Aerosols form a hot topic in today's world, with increasing concern over the impact of these tiny particles. They play a significant role in the haze and smog phenomena, which not only affect visibility but also have profound effects on climate change. Aerosols can influence climate through their interactions with sunlight, both by scattering and absorbing the light. These processes can lead to a cooling or warming effect, depending on the aerosol type and concentration. Black carbon aerosols, for example, are highly effective in absorbing solar radiation, leading to a warming effect, while sulfate aerosols can reflect sunlight, causing a cooling effect.

Fig. 2: Estimated loss in life expectancy attributable to exposure to fine particulate matter (PM2.5) from anthropogenic emissions for the year 2000 (left) and projected for mainland Europe.

Temperature rise over mainland Europe since 1950. Annual temperature differences for the period 1950 to 2005 with respect to the 1961–90 climatological mean for mainland Europe.

MAINLAND EUROPE

The period from 1990 to the present shows a reversal of the trend into a brightening trend. In the period from 1990 to the present, greenhouse warming has been +0.38°C per decade (Figure 4), significantly higher than in any other period since the pre-industrial era.

INTERACTIONS BETWEEN AEROSOL POLLUTION AND CLIMATE

Emissions of aerosols have decreased in recent decades, leading to a reduction in their impact on climate. These changes are driven by policy efforts to reduce air pollution, which also have implications for controlling climate change. The reduction in aerosols has been accompanied by a decrease in cloud albedo, leading to an increase in global warming.

Fig. 3: Variability of cloud cover due to aerosols and climate change.

In simple terms, radiation budget expresses the balance of incoming and outgoing radiation at the top of the atmosphere. The radiation budget is influenced by the presence of aerosols, which can either absorb or scatter incoming solar radiation, affecting the Earth's energy balance.

Fig. 4: Analysis of data from the Mace Head Global Aerosol Watch (GAW) station. The most rapid reduction trend is seen for SOx.

Radiative forcing is the change in the Earth's energy balance due to changes in the radiative properties of the atmosphere. Radiative forcing is a key parameter in climate modeling, with aerosols playing a significant role in modifying the Earth's energy balance.

INTERACTIONS BETWEEN AEROSOL POLLUTION AND CLIMATE

Through the atmosphere, the loss of fine particulate matter (PM2.5) from anthropogenic emissions has led to a reduction in cloud albedo, thus reducing the Earth's energy balance. This has resulted in an increase in global warming, as aerosols have a strong influence on climate change.

Fig. 5: Aerosol loading over Europe and the effects on cloud albedo.
AEROSOLS AND AIR POLLUTION

The presence of aerosols in the atmosphere has played an important role in partly offsetting global warming by reducing the current rate of temperature increase. The gradual cleaning of air to protect public health and the environment, starting in the 1950s, has revealed the greater extent of global warming and the temperature rise caused by greenhouse gas emissions.


during the 1960s, after which a further and more rapid rise in temperature, resulting from aerosol emission controls is evident and approaches the temperature increase from LLGHG alone.

FUTURE DIRECTIONS:

INTERACTIONS BETWEEN AEROSOL POLLUTION AND CLIMATE

Dust and smoke are not the only pollutants that have long-term effects in the atmosphere. Since the 1990s, after which a further and more rapid rise in temperature, resulting from aerosol emission controls is evident and approaches the temperature increase from LLGHG alone.

Emission trends, pollution trends and future projections – an emissions perspective


to have been obscuring, or suppressing, greenhouse warming with reduced, or even negative trends, for global...
AEROSOL PARTICLES AND CLIMATE

Aerosol particles have a windborne or airborne nature and are highly reactive with respect to chemical and physical transformation, leading to net radiative forcing of the atmosphere. Aerosols can act as cloud condensation nuclei, which indirectly affect ice crystal formation and cloud albedo. They also absorb solar radiation and can cause warming. Aerosols are emitted from both natural and anthropogenic sources, including volcanic eruptions, biomass burning, and industrial processes. They can also influence cloud formation, precipitation, and the hydrological cycle.

The particle number concentration, size distribution, and chemical composition are critical factors in determining the net radiative forcing. Aerosols can act as both direct and indirect radiative forcing agents. Direct forcing refers to the direct absorption or scattering of solar radiation by the aerosols, while indirect forcing occurs through the modification of cloud properties, such as cloud droplet size and cloud albedo. The combination of these processes can lead to local cooling or warming effects.

In addition to their direct and indirect effects on the climate system, aerosols also impact air quality and precipitation patterns. They can cause haze layers, which can reduce visibility and affect human health. Aerosols also interact with greenhouse gases, such as carbon dioxide, to influence the climate system. The interactions between aerosols and greenhouse gases are complex and depend on a variety of factors, including the size and composition of the aerosols, the chemical processes involved, and the regional and temporal scales.

The aerosol indirect effect is a significant contributor to the overall radiative forcing and can play a crucial role in understanding the climate system. The aerosol indirect effect is a function of the cloud properties and the aerosol characteristics, such as size, concentration, and type. The aerosol indirect effect can be positive or negative, depending on the specific conditions and processes involved.

AEROSOL PARTICLES AND HEALTH

Aerosol particles can also have significant health impacts, particularly for those with respiratory or cardiovascular conditions. Fine particulate matter (PM2.5) and other small aerosols can penetrate deep into the lungs and cause respiratory irritation, lung inflammation, and other health effects. Long-term exposure to high levels of aerosols, especially PM2.5, can contribute to chronic health problems, including asthma, chronic obstructive pulmonary disease (COPD), and cardiovascular disease. Aerosols can also act as carriers of other harmful substances, such as heavy metals and organic compounds, which can amplify their health effects.

Air quality regulations and policies are important in reducing aerosol emissions and improving air quality. These regulations can help protect public health and reduce the burden of respiratory and cardiovascular diseases. In addition to regulations, new technologies and approaches are being developed to monitor and reduce aerosol emissions, such as aerosol control devices and emissions reduction strategies.

>In conclusion, aerosols have a significant impact on climate and health. Reducing aerosol emissions and improving air quality are crucial for mitigating the effects of climate change and protecting public health. Further research and development are needed to better understand the complex interactions between aerosols, climate, and health, and to develop effective strategies for mitigating their impacts.

Fig. 1: Black smoke and excess deaths during the 1982 Dublin smog event. (Source: Stanhill and Cohen, 2001).

Fig. 2: Aerosol pollution (PM2.5) over Europe, 1990-2010. (Source: Philipona et al., 2009)

Fig. 3: Interactions between aerosol air pollution and climate. (Source: Rosenfeld et al., 2008)

Fig. 4: Aerosol indirect effect on climate warming.

Fig. 5: Aerosol direct and indirect forcing on climate warming.

Fig. 6: Aerosol interactions with climate and air quality.

Fig. 7: Aerosol effects on cloud formation and precipitation.
Aerosol emissions are being reduced to improve air quality and reduce health risks. In Ireland, NOx, SOx, and PM2.5 emissions have decreased significantly. For example, PM2.5 levels have decreased from 1.5 μg m⁻³ in 2001 to ~0.5 μg m⁻³ in 2009. Surface solar radiation increases in line with sulphate mass reductions.

**IN CONCLUSION**

- Aerosol air pollution has been showing the full extent of 2000's global warming.
- Aerosol reductions are being reduced to improve air quality and reduce health risks.
- Less cooling from cleaner air leads to increased net forcing associated with reduced tropospheric ozone as its precursors are reduced.

**REFERENCES**


**Figures**

- **Fig. 5**: NOx, SOx and PM2.5 emissions from Ireland from 2001 to 2009; (b) surface solar radiation versus sulphate mass at Mace Head, 2002-2009.
- **Fig. 6**: Illustrates the current sulphate mass loadings, along with temperature fields, over Europe for August 2006, and future trends based on the RCP6.0 emission and economic development pathway for the time-slice years 2050 and 2100.
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Aerosol air pollution has been obscuring the full extent of warming and cooling but to improve air quality and public health; it should also be acknowledged that concomitant with the reduction in negative radiation forcing associated with the reduction of the aerosol component of air pollution, there is also a reduction in the positive forcing associated with tropospheric ozone as its precursor gas (e.g. NOx, SOx and PM2.5).

Looking into the most likely future pollution storylines, the IPCC AR5 (2014) will be the guide for the climate change action plan which will be developed in 2015. The reducing emissions trend manifests itself in a striking anti-correlation between NOx emissions and surface solar radiation; NOx emissions have decreased by 13% between 2002 and 2012 to 12.8 Gg year-1 in 2012 (Carbery et al., 2013) and SO2 emissions reduce almost linearly until 2100 to less than 25% of current emissions (110 Tg SO2 year-1 in 2000 to 25 Tg SO2 year-1 in 2100). The scenario RCP6 leads to a radiative forcing of 6 Wm-2 by 2100.

The most likely future scenarios for NOx and SO2 emissions from Ireland from 2001 to 2012 are shown in Figure 1. Emissions of NOx decreased by 13% between 2002 and 2012 to 12.8 Gg year-1 in 2012 (Carbery et al., 2013) and SO2 emissions reduce almost linearly until 2100 to less than 25% of current emissions (110 Tg SO2 year-1 in 2000 to 25 Tg SO2 year-1 in 2100). The scenario RCP6 leads to a radiative forcing of 6 Wm-2 by 2100.

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