climate

Editorial

Air Quality in a Changing World

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1. Introduction

Air pollution is one of the most concerning environmental threats to human health. According to the World Health Organization (WHO), exposure to various ambient air pollutants caused 4.2 million global premature deaths in 2016 [1]. By 2019, 99% of the world's population still lived in areas with poor air quality where the WHO standard was not fully met [1]. The strong health impact of poor air quality has raised increasing concerns from both scientific communities and governments. On a global scale, addressing air quality issues is directly mentioned in the Sustainable Development Goal (SDG) targets 3.9 (reduce illnesses and deaths from hazardous chemicals and pollution), 7.1 (universal access to modern energy), and 11.6 (reduce the adverse per capita environmental impact of cities). To address air quality issues, various environmental policies have been implemented worldwide over recent decades, especially in developing countries. However, the impacts of these policies have not fully been evaluated, which hinders proper policymaking regarding future emission reduction measures.

With rapid industrialization and globalization, we are also facing the serious issue of climate change. It is the a consensus that human activities (e.g., the utilization of fossil fuels, land use and land cover change, population growth) have greatly accelerated the rate of climatic change over the past two centuries, which is expected to continue in the future. To mitigate climate change and minimize its consequences, more than 190 countries joined the Paris Agreement in 2015 and agreed to limit climate warming. Subsequently, many countries announced their Nationally Determined Contributions (NDC) with post-2020 climate actions to achieve the peaking of greenhouse gas emissions as soon as possible. These actions (e.g., replacing fossil fuels with renewable energies, upgrading industrial structures and technologies, and expanding city greenery) can also bring large benefits to air quality and human health [2]. However, to what extent these climate actions can mitigate air pollution remains highly uncertain. Understanding the relationship between climate policies and air quality for the present will help better protect human health in the future.

The recent advances in monitoring networks and modeling techniques have greatly strengthened our ability to interpret the consequences of environmental/climate policies on air quality. By taking advantage of this, we initiate this Special Issue entitled "Air and Water Quality in a Changing World".

2. Aims and Scope

This Special Issue aims to better understand the response of air quality to climate change and environmental/climate policies from a global perspective. Emphases are on the interpretation of such responses by monitoring and/or modeling air pollution on multiple scales. By collecting papers relevant to this topic, we hope to propose better strategies for improving air quality in a changing climate.

3. Presentation of the Published Papers

The Special Issue is contributed to by five studies that cover (1) multiple research domains, including Europe, North America, and Asia (the three continents with the most concerning air quality issues); (2) diverse spatial scales ranging from individual monitoring sites, community, city, and national scales; and (3) different air pollutants including heavy metals, nitrogen oxides (NO_x), ozone, particulate matters and their precursors. By using various techniques (including routine monitoring networks, city campaigns, and modeling), these studies discuss how air quality responds to climate/meteorological changes and emission mitigation policies. The results can greatly benefit the scientific community and future policymaking.

In the paper entitled "Possibilities of Sustainable Development including Improvement in Air Quality for the City of Murmansk-Examples of Best Practice from Scandinavia", Huber et al. [3] measure the heavy metal pollution in the Russian city of Murmansk, one of the largest cities located in the Arctic. This territory is of particular importance, as the high-latitude location results in a much stronger feedback to climate change [4]. The campaign throughout the city allows the authors to track the most important air pollution sources, including the outdated heating system and coal dust from the port and vehicles. Accordingly, the authors propose mitigating pollution from these major sources by updating the heating technologies, introducing more renewable energy, increasing the thermal insulation of buildings, and facilitating public transportation. These practical solutions can also offer suggestions for other cities with a similar climatology to Murmansk.

The paper entitled "Air Pollution within Different Urban Forms in Manchester, UK" investigates the impacts of different urban forms on NO_2 (nitrogen dioxide) pollution in Manchester. The aim of this work is to define the driver of air pollution in the community microclimate and provide suggestions for future urban design/planning. By correlating the observed NO_2 concentration and meteorological data, the author shows that air temperature and wind speed dominate the NO_2 pollution levels [5]. This finding further triggers model simulations with four hypothetical neighborhood forms. As a result, the author concludes that a linear north–south building formation has the greatest potential to reduce air pollution by blocking the wind transportation within the neighborhood. This suggests the importance of considering the location of air pollution sources and the direction of prevailing wind when designing a clean neighborhood.

The paper entitled "Combined Effect of High-Resolution Land Cover and Grid Resolution on Surface NO_2 Concentrations" analyzes the spatial variability of modeled NO_2 concentration in response to different horizontal resolutions over Portugal using the WRF-Chem model [6]. Previous studies have reported the critical influences of horizontal resolution on a regional scale, e.g., [7]. On top of that, the authors further consider the impacts of using high-resolution land cover data as input. They show that applying high-resolution land cover data can highlight pollution hotpots on an urban scale, but with small impacts found for a larger scale if the input emissions remain in a coarse resolution. They argue that increasing the model resolution does not always benefit to model performance unless the correspondingly high-resolution input data for emissions and land cover are provided.

In the paper entitled "Changing Air Quality and the Ozone Weekend Effect during the COVID-19 Pandemic in Toronto, Ontario, Canada", Gough and Anderson [8] focus on the NO_x and ozone during the 2020 COVID-19 pandemic in Canada. By comparing the 2020 data with the 10-year (2010–2019) climatological records in two observation sites in Toronto, they show that both NO and NO_2 decreased dramatically during the pandemic, possibly resulting from the reduced traffic. However, the ozone concentration does not show a corresponding decrease due to the VOC-limited ozone chemistry. The results provide important information for making proper ozone mitigation policies.

The paper entitled "Ambient Air Quality Synergies with a 2050 Carbon Neutrality Pathway in South Korea" evaluates the impacts of the carbon neutrality pathway on air quality in South Korea [9]. Under the Paris Agreement, South Korea declared a series of climate actions to achieve carbon neutrality by 2050, which can synergistically improve air quality. By comparing the claimed goal of carbon neutral by 2050 with a business-as-usual scenario, the author shows that South Korea would accumulatively cut down 5539 million tons of CO_2 equivalent greenhouse gas emissions during the period of 2022–2050 from the announced climate actions. Simultaneously, these climate actions can also greatly reduce the ambient $PM_{2.5}$ concentration, avoiding 3389 years of life lost for the whole country in 2050. This study provides important evidence on the potential benefits from strong climate mitigation actions.

4. Conclusions

In recent years, more and more countries have started to take actions to deal with air pollution and climate issues. This provides a good opportunity for studying the relationships between air quality and environmental/climate policies. The world is globalizing, and so is air pollution. The best solution to take the future challenges of air quality and climate change can be expected from cooperation among countries, which relies on scientific research from a global perspective. The papers collected in this Special Issue present research on air quality from different regions and scales, facilitating knowledge exchanges among science units and governments.

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References

1. World Health Organization. WHO Ambient Air Quality Database: 2022 Update. Available online: https://www.who.int/publications/m/item/who-air-quality-database-2022 (accessed on 3 November 2022).
2. Shindell, D.; Borgford-Parnell, N.; Brauer, M.; Haines, A.; Kuylenstierna, J.C.I.; Leonard, S.A.; Ramanathan, V.; Ravishankara, A.; Amann, M.; Srivastava, L. A Climate Policy Pathway for Near- and Long-Term Benefits. *Science* **2017**, *356*, 493–494. [CrossRef] [PubMed]
3. Huber, M.; Rusek, A.; Menshakova, M.; Zhigunova, G.; Chmiel, S.; Iakovleva, O. Possibilities of Sustainable Development including Improvement in Air Quality for the City of Murmansk-Examples of Best Practice from Scandinavia. *Climate* **2022**, *10*, 15. [CrossRef]
4. Winton, M. Amplified Arctic climate change: What does surface albedo feedback have to do with it? *Geophys. Res. Lett.* **2006**, *33*, L03701. [CrossRef]
5. Taleghani, M. Air Pollution within Different Urban Forms in Manchester, UK. *Climate* **2022**, *10*, 26. [CrossRef]
6. Silveira, C.; Ferreira, J.; Tuccella, P.; Curci, G.; Miranda, A.I. Combined Effect of High-Resolution Land Cover and Grid Resolution on Surface NO_2 Concentrations. *Climate* **2022**, *10*, 19. [CrossRef]
7. Schaap, M.; Cuvelier, C.; Hendriks, C.; Bessagnet, B.; Baldasano, J.M.; Colette, A.; Thunis, P.; Karam, D.; Fagerli, H.; Graff, A.; et al. Performance of European chemistry transport models as function of horizontal resolution. *Atmos. Environ.* **2015**, *112*, 90–105. [CrossRef]
8. Gough, W.A.; Anderson, V. Changing Air Quality and the Ozone Weekend Effect during the COVID-19 Pandemic in Toronto, Ontario, Canada. *Climate* **2022**, *10*, 41. [CrossRef]
9. Phillips, D. Ambient Air Quality Synergies with a 2050 Carbon Neutrality Pathway in South Korea. *Climate* **2022**, *10*, 1. [CrossRef]