remote sensing

Editorial

Editorial for the Special Issue "Air Quality Research Using Remote Sensing"

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Air pollution is a worldwide environmental hazard with serious consequences for health and climate as well as for agriculture, ecosystems, and cultural heritage, among others. According to the WHO, there are 8 million premature deaths every year resulting from exposure to ambient air pollution. In addition, more than 90% of the world's population lives in places where air quality is poor, exceeding the recommended limits; most of these places are in low- or middle-income countries. Air pollution and climate influence each other through complex physicochemical interactions in the atmosphere, altering the Earth's energy balance, with implications for climate change and air quality.

It is vital to measure specific atmospheric parameters and pollutant concentrations, monitor their variations, and analyze different scenarios with the aim of assessing air pollution levels and developing early-warning and forecast systems; such developments provide a means of improving air quality and assuring public health in favor of a reduction in air pollution casualties and a mitigation of climate change phenomena. Eleven research papers were published in this Special Issue, comprising one communication paper [1], seven articles [2–8], two technical notes [9,10], and one letter [11]. The published research signals the potential of applying remote sensing data in air quality studies, including combination with in situ data [1,3,6,8], modeling approaches [2,9,11], and the synergy of different instrumentations and techniques [4,5,7,10]. Significant pollutants considered in the studies include aerosols—using $PM_{2.5}$ and aerosol optical depth (AOD) as quantification variables [1,2,4,5,9]—nitrogen dioxide (NO_2) [7,8,11], formaldehyde (HCHO) [3], and carbon monoxide (CO) [6,10], among others [10].

The influence of meteorology on seasonal $PM_{2.5}$ concentrations and AOD was analyzed, providing insight that may contribute to improving the retrievals of surface $PM_{2.5}$ from satellite AOD [2]. The mechanisms of $PM_{2.5}$ regional transport from biomass burning in Southeast Asia were examined for a case study during springtime, with an emphasis on the role of meteorology [9]. Furthermore, the influence of urban form on $PM_{2.5}$ surface concentrations was investigated, providing a seasonal analysis method which is relevant for urban planning strategies surrounding air quality improvement in populated areas [4]. New methods combining remote sensing data and additional ancillary datasets with machine learning algorithms were proposed, allowing us to retrieve surface $PM_{2.5}$ concentrations [1] and AOD [5]. Such prediction schemes can provide significant information for advances in air quality research.

The importance of drones for monitoring limited areas, often in areas of difficult access, is increasingly being recognized. An application of drones over a wastewater treatment plant, permitting the real-time monitoring of gaseous pollutants, was demonstrated in [10], and open challenges were identified.

An evaluation of satellite retrievals of HCHO, a recognized hazardous air pollutant, using ground-based data was carried out for a ten-year period [3]. Results suggest that satellite results are more prone to seasonal variations than ground-based measurements and show evidence of a latitude dependency with a seasonal bias. Studies of satellite retrievals in comparison with ground-based measurements are very pertinent considering the use of new Earth observation sensors for air quality monitoring. CO concentration variability was also assessed from both satellite and ground-based measurements [6]. The authors of [6] examined the horizontal and vertical variations in CO concentrations caused by the COVID-19 lockdown in 2020 and compared the contributions from different sources with results from 2019.

The distribution and trends of tropospheric NO_2 at a global scale were analyzed for a 13-year period using satellite retrievals [8]. Ground-based measurements were also used for comparison purposes. Hotspots of high concentrations of this air pollutant were identified, as well as regions of negative and positive trends during the period of study. The highest concentrations of tropospheric NO_2 were detected in recent years, indicating the importance of monitoring anthropogenic emissions and implementing further actions for their reduction. The authors of [11] used satellite data combined with air quality modelling to estimate the impact of the COVID-19 lockdown on tropospheric NO_2, while analyzing the role of meteorology and sampling variability in the process. Satellite data were used in combination with data from ground-based NO_2 concentration measurements, NO_x emissions, land uses, road networks, and population densities, in order to develop a regression model for determining surface NO_2 with a high spatial resolution [7]. The model was applied at a city scale, with the results highlighting the key role of Earth observation technologies in support of exposure assessments and policy development for air quality control.

The publications in this Special Issue highlight the importance and topicality of air quality studies and the potential of remote sensing, particularly from Earth observation platforms, in contributing to this topic.

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