Editorial for the Special Issue “Atmospheric Dispersion and Chemistry Models: Advances and Applications”

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Atmospheric dispersion and chemical transport models (CTMs) are a key tool in both atmospheric chemistry and environmental sciences. From urban air pollution modeling to ozone depletion, these models give us a picture, at different scales, of the distribution of species concentrations and pollutant deposition rates, among other relevant quantities. These models help us to interpret observational data which, in some cases, are sparse and incomplete.

Many dispersion models and CTMs have been developed to date, with both Eulerian and Lagrangian approaches, each of which is mostly focused on a particular spatial scale and application. A large portion of them do not generate their own meteorological field, which is previously computed by an external meteorological model, i.e., a complete meteorological prediction is not required to be run for each dispersion simulation. Therefore, these models can significantly minimize the computational times associated with an online approach, allowing for studies that would require enormous times in other types of models, and in applications where feedback from the species distribution to the meteorological field is not necessary.

Their usefulness is not limited to only scientific research, but also to supporting environmental decision making. Therefore, the characterization of model uncertainties and model validation play a central role in the development of model applications.

This Special Issue (SI) of the open access journal *Atmosphere* aims to cover papers related to all aspects involved in the development of atmospheric dispersion models and CTMs, such as the implementation of new physical and chemical schemes, coupling with meteorological models, application studies related to atmospheric transport and chemistry, urban air quality assessments, and model evaluations. This volume comprises 11 high-quality papers that were accepted for publication from the submissions received for this SI. These papers are summarized as follows, in order of their publication.

The first paper published in this SI, by Mazzeo et al. [1], used an air quality model, coupled online with a meteorological model, to simulate the impact of emission reductions on PM2.5 in the West Midlands region of the United Kingdom. They showed several results concerning the effectiveness of mitigation policies in reducing anthropogenic emissions under different simulated scenarios. The second paper, by Chen et al. [2], used two dispersion models to analyze the potential detection of methane emissions by a continuous monitoring sensor network in an oil and gas production region in Texas and to assist in the design of the network. They also analyzed the sensitivity of this network under different scenarios, including meteorological conditions, emission fluxes, and intermittency. In the third paper, Kubas et al. [3] studied the impact of an accidental emission of dangerous substances in the Slovak Republic, in the context of population and environment protection in crisis management and emergency planning. Their results could be useful for authorities and rescue system units. Liu et al. [4] analyzed the relationship between sandstorm periods and the transport and dispersion of particulate emissions from coal bases in northwest China, assisted by a backward trajectory analysis performed with an atmospheric dispersion model. Their results could be useful for preventing possible risks to human health. Cogliati et al. [5] studied the distribution of bioaerosols in the vicinity of a cattle feedlot in Argentina. Bioaerosol emissions from intensive livestock breeding, which include...
bacteria, viruses, and other parasites, can cause severe human diseases. They used an atmospheric dispersion model to support their study, predicting the distribution and concentration of bioaerosols as a function of wind patterns. Tølløse et al. [6] focused on the estimation of the source term in atmospheric dispersion models in the case of emissions of hazardous radioactive matter to the atmosphere due to a nuclear accident, when there is no reliable estimation of the source term. The Bayesian inversion method for probabilistic estimation of the source term they developed is intended for operational use in the early stages of such events. Kiselev et al. [7] focused their study on assessing uncertainties in the modeling of wet raindrop deposition. They presented the results of a multi-model ensemble construction to determine the below-cloud scavenging coefficient in atmospheric dispersion and chemistry models, which could be used to improve the current approaches associated with modeling the distribution of pollutants in the atmosphere in the case of an emergency. Parra [8] evaluated several land surface schemes in an online-coupled atmospheric chemical model applied to the complex Andean region of Ecuador, where atmospheric modeling is challenging. His findings provide insights into the influence of land surface schemes on meteorology and air quality modeling. Bukosa et al. [9] used a global CTM to perform chemical simulations of carbon dioxide, carbon monoxide, and methane. They improved the model setup from the standard procedure implemented in the CTM to compute some chemical terms more consistently, discussing the differences between the two approaches. Talafha et al. [10] applied an atmospheric dispersion model to evaluate the behavior of radionuclides released to the atmosphere during a hypothetical accident at a nuclear research reactor located in Jordan. This study could provide insights for emergency preparedness and response planning to mitigate the radiological consequences of a nuclear accident at such a reactor. Finally, Lipták et al. [11] presented an atmospheric dispersion model based on a Lagrangian approach integrated into a nuclear decision support system. Their development focused on strict time constraints, as these would exist when running the necessary simulations right after an event. Their results suggest that the computation of atmospheric dispersion and radiological impacts can be performed using a powerful computer on a timescale equal to that of the actual event.

In summary, the 11 papers included in this Special Issue, “Atmospheric Dispersion and Chemistry Models: Advances and Applications”, published between 2022 and 2023, cover several developments and applications related to atmospheric dispersion and chemistry models. These studies highlight the potential benefits of using such models for many scientific and technical applications in atmospheric chemistry and environmental sciences, involving, for example, the characterization of aerosols and chemical species in the atmosphere, and risk analyses and decision making for potential pollutant releases, nuclear accidents, and climate change.

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References


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