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Editorial

Preface: Ozone Evolution in the Past and Future

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1. Introduction

The stratospheric ozone plays an important role in the protection of the biosphere from the dangerous ultraviolet radiation of the sun. It also forms the temperature structure of the stratosphere and therefore, has a direct influence on the general circulation and the surface climate [1,2]. The tropospheric ozone can damage the biosphere, impact human health, and plays a role as a powerful greenhouse gas [3,4]. That is why the understanding of the past and future evolution of the ozone in different atmospheric layers, its influence on surface UV radiation doses, and human health is important. The discovery of the ozone hole in 1984/1985 led to limitations in the production of halogen-containing, ozone-depleting substances by the Montreal Protocol and its amendments (MPA). This measure aimed to prevent ozone layer depletion and to guarantee future recovery of the ozone shield in the future. However, the expected ozone recovery and the effectiveness of MPA are now being questioned due to the continuous negative ozone trend in the lower stratosphere [5] and the appearance of a large ozone hole over the Arctic in 2020 [6]. The abovementioned facts inspired the appearance of this Special Issue. Initially, I aimed to publish studies of the stratospheric and total column ozone trends, but during work on this issue, I decided to also accept papers related to tropospheric ozone effects and trends. Thus, this Special Issue includes recent experimental, statistical, and modeling works describing several aspects of the ozone layer's state and evolution. In the next section, the individual contributions are summarized and divided into two broad topics covering the issues related to the stratospheric and tropospheric ozone layer.

2. Summary of This Special Issue

2.1. Stratospheric Ozone Evolution

Smyshlyaev et al. [7] attempted to elucidate the contribution of different natural and anthropogenic factors to the observed stratospheric ozone variability for the 1979–2020 period, exploiting their state-of-the-art chemistry–climate model. They also compared results from the late twentieth and early twenty-first century against ground-based and satellite observations. In particular, their model showed that WMO (World Meteorological Organization) 2011 scenarios probably overestimated the reduction in hODS (halogen containing Ozone Depleting Substances) emissions into the atmosphere in 2010–2020. Egorova et al. [8] addressed ozone layer evolution during the early 20th century using their chemistry–climate model driven by all known external drivers. They concluded that enhanced solar UV radiation is the main driver of the stratospheric and total column ozone changes. This finding would be useful to constrain solar forcing magnitude if some reconstructions of the ozone are available. Chubarova et al. [9] analyzed the evolution of erythemal radiation over Northern Eurasia caused by total column ozone and cloud amount variabilities, acquired from the observations and model simulations. They found generally positive trends for all months and locations except in the central Arctic in July, which is driven by the increase in cloud amount. These conclusions are in agreement with a recently published modeling study [10] on future ozone layer and UV evolutions. The accuracy of the trend analysis depends on the quality of the observational time series. Krizan et al. [11] carefully investigated the ozone time series from MERRA-2 reanalysis and found several discontinuities, which can affect the ozone trend analysis mostly above the 4 hectopascal pressure layer. A new and promising statistical method for the trend analysis based on Empirical Wavelet Transform was proposed and exploited by Mbatha and Bencherif [12]. Using this approach, they performed a detailed analysis of the total column ozone data measured in Buenos Aires, Argentina, and obtained a robust ozone recovery during the 2010–2017 period, excluding ozone decline in 2015 caused by the Calbuco volcanic event. Mkololo et al. [13] studied stratospheric ozone changes and stratosphere–troposphere exchange events over the Irene station during the 2000–2007 and 2012–2015 periods. They obtained a negative ozone trend by up to 9% in the 12–24 km layer in the 2012–2015 period relative to the 2000–2003 average. This result is in agreement with the analysis of the satellite data by Ball et al. [5].

2.2. Tropospheric Ozone Evolution

Tropospheric ozone layer evolution during the early 20th century was addressed by Egorova et al. [8], using their chemistry–climate model driven by anthropogenic and natural forcing. They obtained an up to 20% enhancement of the ozone in the northern boundary layer during the 1910–1940 period, driven by anthropogenic ozone precursors. Diaz et al. [14] evaluated the 30-year surface ozone trend in the United Kingdom using measurements from 13 rural and 6 urban sites. They showed that introduced emission control facilitated cleaner air with a much smaller number of days with high surface ozone abundance. They also stated that the highest number of days with high surface ozone concentration is reached in May for all stations. The contribution of the stratospheric ozone intrusion to the events with high surface ozone concentration in China was analyzed by Wang et al. [15] using a Lagrangian Particle Dispersion Model driven by meteorological reanalysis data. They concluded that stratospheric intrusions can be responsible for about 15% of severe ozone pollution events and should be considered in surface ozone forecast and control. The potential impact of such strong pollution events on mortality rate was evaluated by Park [16]. He showed that in Seoul (South Korea), elevated surface ozone substantially contributes to mortality rates during spring, while the high air temperature is more dangerous during the summer. These conclusions are useful for local authorities and air quality control system developers.

3. Conclusions

This Special Issue consists of nine contributions discussing different aspects of ozone layer evolution. I hope the obtained results will be of interest to the ozone community and inspire new studies in this direction using models and observations.

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