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EDITORIAL

Comprehensive Studies on Atmospheric Sciences

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Atmospheric compositions are changing rapidly in the past few decades with the developments of human activities, including industry, energy use, traffic, agriculture, land use, urbanization, resulting in the changes in the atmosphere, biosphere, land, ocean, along with climate [1,2].

Large quantities of air pollutants, gases (NOx, SO_2, CO), particulate matter (PM, $PM_{2.5}$, PM_{10}, black carbon, etc.) are emitted into the atmosphere, and small sized particles ($PM_{2.5}$, PM_1, secondary organic aerosols (SOA)) are produced via chemical and photochemical reactions. The gases, liquids and particles (GLPs) absorb and scattering global solar radiation (UV, visible (VIS) and near infrared (NIR)) and regulate its distributions in the atmosphere, at the top of the atmosphere (TOA) and the surface. The GLPs attenuate the global solar radiation in the atmosphere and affect its strength arriving at the ground. These energy influences the horizontal and vertical movements of the atmosphere, as well as precipitation. Due to differences between the city and the rural regions in GLP loads and solar radiation, there are evident differences in precipitation and long-term variations [3]. The GLPs also influence the climate and climate change through interactions with shortwave and longwave radiations.

Ozone pollution is becoming more severe globally. It is formed from its precursors (NOx, SO_2, anthropogenic and biogenic volatile organic compounds (AVOCs, BVOCs)), triggered by UV and visible radiations. OH radicals play pivotal roles in chemistry and photochemistry, especially O_3 formation. There are missing OH reactivity and arguments for its causes. The unmeasured and unknown BVOCs and BVOC oxidation products are possible reasons [4,5]. Until now, there are still large uncertainties in measurements and model simulations of O_3, OH, BVOCs and SOA [6]. Satellite data of GLPs provide unparalleled contributions to investigate chemical and photochemical mechanisms that can be applied in air pollution policy

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making [7].

Vegetation utilizes photosynthetically active radiation (PAR) in growth and biological processes and participates in 1) carbon exchange (gross primary productivity GPP, respiration and net ecosystem exchange NEE), which affects climate warming [8], and 2) emissions of BVOCs, which contribute to the changes of atmospheric GLPs in single phase and the conversions between gases, liquids and particles, as well as climate change via direct absorption and indirect use of solar radiation [3]. The process-based dynamic global vegetation models, machine learning and empirical models are widely used to calculate the carbon balance. Process-based and empirical models are extensively used to estimate BVOC emissions, e.g., (Model of Emissions of Gases and Aerosols from Nature) [9].

BVOCs are highly reactive and oxidized to small size aerosols, which also contribute to cloud condensation nuclei and cloud formation [10], then influence solar radiation transfer and its dynamic balance.

The emission inventories of GLPs are significant inputs for chemical models and urgently required, particularly BVOC emission inventories, as BVOCs can react with most chemicals and produce new GLPs (O_3, HCHO, SOA). BVOCs play key bridges in GLP conversions and solar energy utilization [3,7,9,10]. The measurements of BVOC emissions from branch to regional scales and model estimates in regional and global scales are needed, so as to reduce the large uncertainty in BVOC emission estimates [9]. The accurate BVOC emission fluxes are valuable for its model development and estimates, and then the improvements in O_3 and SOA simulations.

Non-linear relationships exist between O_3 and its precursors and solar radiation. The processes in O_3 photochemistry are complicated, and some hypotheses are used in chemical models (Weather Research and Forecasting (WRF), Community Multiscale Air Quality (CAMQ)), due to limitations of current understanding. O_3 flux is an important input in models and more measurements in the forests and other sites are necessary. Though some progresses have been made in model simulations of the concentrations and/or fluxes for air pollutants, OH radicals, AVOCs, and BVOCs, more deepened and specific studies in the processes and related mechanisms are needed.

To study solar radiation, many kinds of models, including radiative transfer and empirical models are widely applied to compute global, direct and diffuse solar radiation at the surface and at the TOA [3]. Most models show better performances under clear skies, but there are urgent needs to improve the descriptions and simulations under high GLP loads, including clouds, aerosols, and air pollutants. In addition, ground-measured and satellite-retrieved solar radiations are beneficial in the investigation of solar radiation, as well as validations of radiative transfer and empirical models.

Most sites and three Polar Regions have been experiencing climate warming reported by the Intergovernmental Panel on Climate Change (IPCC) and many studies [3]. Although some mechanisms are proposed, e.g., anthropogenic increases in greenhouse gases (CO_2, CH_4, N_2O), there are still challenges to find common causes. Solar radiation plays an important role in climate change, and its transfer and distribution in the atmosphere, at the TOA and the surface are recommended to be fully investigated regional and globally [3]. The increases or changes of GLPs (including absorbing and scattering components) lead to the changes in the losses of solar radiation as well as sensible heat and latent heat, associating with the rainfall, rainstorm, flood, etc. Surface warming may increase global mean rainfall. At present, how to accurately forecast the rainfall is an urgent task.

To solve above issues, they are big challenges to improve measurement technologies and model simulation capabilities of GLP species and their concentrations, vertical profile, and better understand the each process and mechanisms in physics, chemistry and biology and multiple interactions in the sun-atmosphere-surface (including land, vegetation, ocean and anthroposphere) system. The combination of the ground-, tower-, airplane-, and satellite- based observations is suggested. With the progress on observations and models, more detailed processes and mechanisms can be determined quantitatively. Limited by developments of the technique and models, energy and energy balance methods are useful to study above processes and mechanisms [3,7] with less hypotheses and parameters. Considering the significant foundation of solar energy, it would make great progress to improve the accuracy of the simulations of global solar radiation and its components under all skies, especially high GLP loads. Upon this, the simulation uncertainties of GLPs can be reduced evidently. We should find a way to create a harmonious environment between human being and nature. Finally, better understanding of the laws of nature, and thorough simulations and forecasts of the atmosphere, biosphere, hydrosphere and anthroposphere can be achieved simultaneously through the integrated investigations; even there is a long way to go.

References

[1] IPCC. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; in press; Cambridge University Press: Cambridge, UK, 2022.

[2] Hansen, J., Ruedy, R., Sato, M., et al., 2020. Global surface temperature change. Reviews of Geophysics. 48, RG4004.

[3] Bai, J.H., Wan, X.W., Arslan, E., et al., 2024. Global solar radiation and its interactions with atmospheric substances, and their effects on air temperature change in Ankara Province. Climate. 12(3), 35.

[4] Di Carlo, P., Brune, W.H., Martinez, M., et al., 2004. Missing OH reactivity in a forest: Evidence for unknown reactive biogenic VOCs. Science. 304, 722–725.

[5] Sanchez, D., Seco, R., Gu, D., et al., 2021. Contributions to OH reactivity from unexplored volatile organic compounds measured by PTR-ToF-MS – a case study in a suburban forest of the Seoul metropolitan area during the Korea–United States Air Quality Study (KORUS-AQ) 2016. Atmospheric Chemistry and Physics. 21(8), 6331-6345.

[6] Tao, Z., Williams, A., Huang, H.-C., et al., 2008. Sensitivity of surface ozone simulation to cumulus parameterization. Journal of Applied Meteorology and Climatology. 47(5), 1456-1466.

[7] Bai, J., de Leeuw, G., De Smedt, I., et al., 2018. Variations and photochemical transformations of atmospheric constituents in North China. Atmospheric Environment. 189, 213–226.

[8] Yu, G., Chen, Z., Piao, S., et al., 2014. High carbon dioxide uptake by subtropical forest ecosystems in the East Asian monsoon region. Proceedings of the National Academy of Sciences. 111(13), 4910-4915.

[9] Guenther, A.B., Jiang, X., Heald, C.L., et al., 2012. The model of emissions of gases and aerosols from Nature version 2.1 (MEGAN2.1): an extended and updated framework for modeling biogenic emissions. Geoscientific Model Development. 5, 1471-1492.

[10] Claeys, M., Graham, B., Vas, G., et al., 2004. Formation of secondary organic aerosols through photooxidation of isoprene. Science. 303, 1173–1176.