atmosphere

Editorial

Climate Change and Its Impacts on Terrestrial Ecosystems: Recent Advances and Future Directions

Cheng Li [1,*], Fan Yang [2], Qitao Xiao [3] and Yao Gao [4]

1 School of Plant Protection, Joint International Research Laboratory of Agriculture and Agri-Product Safety of the Ministry of Education, Yangzhou University, Yangzhou 225009, China
2 Institute of Desert Meteorology, China Meteorological Administration, Urumqi 830002, China; yangfan@idm.cn
3 Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing 210008, China; qtxiao@niglas.ac.cn
4 Finnish Meteorological Institute, P.O. Box 503, 00101 Helsinki, Finland; yao.gao@fmi.fi
* Correspondence: licheng@yzu.edu.cn

With the increasing concentration of greenhouse gases in the atmosphere, climate change is now an indisputable fact and has strong impacts on various terrestrial ecosystems (e.g., cropland, forests, grassland, wetlands, lakes, and deserts) [1]. Over the past few decades, numerous studies have been conducted to improve our knowledge of the spatiotemporal variation in climatic conditions (e.g., temperature, precipitation, and radiation) and these variations' impacts on terrestrial ecosystems [2–4]. In particular, recent multi-source data and rapidly evolving methods are providing opportunities for researchers to better understand the complex ecological responses to climate change.

This Special Issue, entitled "Climate Change and Its Impacts on Terrestrial Ecosystems: Recent Advances and Future Directions", aims to understand the spatiotemporal changes in climate and environmental variables and also to evaluate the response of terrestrial ecosystem to climate change.

A total of eight papers have been published in this Special Issue, three 3 original research articles reporting on the analysis of regional climate and environmental variables.

Wang et al. [5] partitioned the total precipitation into two components (namely, the local evaporation and external water vapor advection) and revised the precipitation recycling ratio model, which is used to assess the contributions of moisture from different water vapor sources to local precipitation in semi-arid inland Eurasia. It was found that the precipitation recycling ratio increased from 1970 to 2017, with obvious seasonality in this region. However, a paradox existed between the increasing precipitation and the decreasing external water vapor input in this region. Using the Clausius–Clapeyron equation, a physical explanation for trends of the precipitation recycling ratio was provided in their paper.

Based on the combination of $PM_{2.5}$ data derived from ground station monitoring and satellite remote sensing estimation from 2000 to 2021, Jin et al. [6] analyzed the spatiotemporal variation characteristics of $PM_{2.5}$ concentrations and pollution levels on annual, seasonal, and monthly scales in the Yellow River Golden Triangle Demonstration Area, China. They found that the annual average $PM_{2.5}$ concentrations showed a trend from increasing to decreasing after 2011. Moreover, the $PM_{2.5}$ concentrations showed a U-shaped variation pattern from January to December each year, and they exhibited a spatial pattern of high values in the central area and low values in the northern and southern parts of the study area.

Dissolved organic carbon (DOC) in inland waters plays a significant role in the global carbon cycle and affects global climate change. Liu et al. [7] used field measurements taken over a year to explore the DOC variability and its influencing factors in ponds draining differently in a typical agricultural watershed (the Tongyang River watershed, China). They

Citation: Li, C.; Yang, F.; Xiao, Q.; Gao, Y. Climate Change and Its Impacts on Terrestrial Ecosystems: Recent Advances and Future Directions. *Atmosphere* **2023**, *14*, 1176. https://doi.org/10.3390/atmos14071176

Received: 5 July 2023
Accepted: 14 July 2023
Published: 21 July 2023

found that the DOC concentration varied among ponds draining in different landscapes. Specifically, the mean DOC concentrations in the natural pond, sewage pond, aquaculture pond, and irrigation pond were 6.17 ± 1.49 mg/L, 12.08 ± 2.92 mg/L, 9.36 ± 2.92 mg/L, and 8.91 ± 2.71 mg/L, respectively. Meanwhile, the DOC variability was positively correlated with nutrients, primary production, and precipitation.

There are three papers in this Special Issue that reported on the response of vegetation growth and agriculture production to climate change.

Qin et al. [8] investigated the temporal changes in vegetation activity responses to rising air temperature in China's temperate zone based on long-term normalized difference vegetation index (NDVI) data sets and air temperature data sets from 1982 to 2015. It was found that the interannual partial correlation between the NDVI and air temperature for the growing season in a 17-year moving window showed a significant decreasing trend during the last 34 years, suggesting that the impact of mean temperature, maximum temperature, and minimum temperature on vegetation activities exhibited a weakening trend. Furthermore, the partial correlation showed a more significant and accelerating decrease for warm years compared to cold years.

Spring phenology is often considered the start of season (SOS) for vegetation. Using long-term NDVI data sets, Li et al. [9] explored the long-term variation in SOS and compared the relative importance of climatic factors affecting SOS variation in northern China. The results showed that the SOS during 1982–2014 had an advancing trend, but it appeared to be reversed after 1998. The preseason minimum temperature was a dominant factor controlling the SOS in most pixels in northern China, followed by the maximum temperature. However, the impacts of temperature on the SOS declined in the period after 1998, especially for maximum temperature.

Zhou et al. [10] employed a random forest model to predict winter wheat yield and nitrogen losses in the middle and lower reaches of the Yangtze River (China) based on CMIP6 meteorological data and related environmental variables under SSP126 and SSP585 emission scenarios. The results showed that future temperature and precipitation changes will decrease winter wheat yield by 2~4% and reduce total nitrogen losses by 0~5%. On this basis, the authors determined that a reduction of 0.3 times the nitrogen and an increase of 0.25 times the nitrogen are the minimum nitrogen reduction and maximum nitrogen increase limits, respectively, for winter wheat field production in the middle and lower reaches of the Yangtze River.

The two other articles in this Special Issue focused on the modelling of regional climate and environmental variables.

The study from Bandira et al. [11] utilized GIS-based multi criteria decision making (MCDM) and NASA POWER data to identify the optimal locations for solar farm installations, taking the George Town Conurbation, Peninsular Malaysia, as a case study. The model output showed the capabilities of the GIS-based MCDM method in the rapid identification of potential areas for solar farm installations while avoiding areas without potential, enabling resources to be focused on the feasible sites. Meanwhile, the performance of the NASA POWER data was satisfactory for the solar radiation and maximum, mean, and minimum temperatures, showing that the climatic data provided by NASA POWER can potentially be used for solar farm site selection in Malaysia.

Global warming could increase the potential for wildfires in the future. Ardiyani et al. [12] developed a hotspot prediction model in the Kalimantan region using climate indicators such as precipitation and its derivatives, ENSO and IOD. They collected the number of hotspots, dry spells, and precipitation from 1997 to 2020 for analysis. A hotspot prediction model was developed using Principal Model Analysis (PMA) as the initial basis of the model. Furthermore, the Bayesian concept significantly improved the accuracy of the PMA-based model, especially during extremely dry conditions such as a strong El Niño or/and strong IOD+.

In conclusion, scientific progress and the recently explored developments are presented in this Special Issue. Those findings help to improve the understanding of climate change and its impacts on terrestrial ecosystems at regional scales. The Guest Editors sincerely thank all authors for their great contributions and hope that this Special Issue will inspire future research on this research area.

Author Contributions: Conceptualization, C.L.; writing—original draft preparation, C.L.; writing—review and editing, F.Y., Q.X. and Y.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the National Natural Science Foundation of China (41801013; 41975010; 42271114), the Royal Society International Exchanges 2022 (IEC\NSFC\223132), the Qinglan Project of Yangzhou University, and the Humanities and Social Sciences Foundation of Yangzhou University (xjj2023-05).

Acknowledgments: The authors sincerely thank Kwok Chun and Thanti Octavianti from the University of the West of England for their valuable suggestions.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. IPCC. 2018: Summary for policymakers. In *Global Warming of 1.5 °C. An IPCC Special Report on the Impacts of Global Warming of 1.5 °C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*; Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, P., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2022; pp. 3–24.
2. Piao, S.L.; Liu, Q.; Chen, A.P.; Janssens, I.A.; Fu, Y.S.; Dai, J.H.; Liu, L.L.; Lian, X.; Shen, M.G.; Zhu, X.L. Plant Phenology and Global Climate Change: Current Progresses and Challenges. *Glob. Chang. Biol.* **2019**, *25*, 1922–1940. [CrossRef]
3. Li, C.; Li, Z.Z.; Zhang, F.M.; Lu, Y.Y.; Duan, C.F.; Xu, Y. Seasonal Dynamics of Carbon Dioxide and Water Fluxes in a Rice-Wheat Rotation System in the Yangtze-Huaihe Region of China. *Agric. Water Manag.* **2023**, *275*, 107992. [CrossRef]
4. Piao, S.L.; Wang, X.H.; Park, T.; Chen, C.; Lian, X.; He, Y.; Bjerke, J.W.; Chen, A.P.; Ciais, P.; Tommervik, H.; et al. Characteristics, Drivers and Feedbacks of Global Greening. *Nat. Rev. Earth Environ.* **2020**, *1*, 14–27. [CrossRef]
5. Wang, X.-Y.; Bao, X.-Y.; Huang, Y.; Li, Z.-W.; Yong, J.-H.; Wu, Y.-P.; Feng, G.-L.; Sun, G.-Q. Physical Explanation for Paradoxical Climate Change in Semi-Arid Inland Eurasia Based on a Remodeled Precipitation Recycling Ratio and Clausius–Clapeyron Equation. *Atmosphere* **2023**, *14*, 376. [CrossRef]
6. Jin, N.; He, L.; Jia, H.; Qin, M.; Zhang, D.; Wang, C.; Li, X.; Li, Y. Spatiotemporal Patterns and Characteristics of $PM_{2.5}$ Pollution in the Yellow River Golden Triangle Demonstration Area. *Atmosphere* **2023**, *14*, 733.
7. Liu, Z.; Sheng, L.; Zhang, X.; Duan, L.; Jiang, Y.; Xiao, Q. Dissolved Organic Carbon Dynamics Variability from Ponds Draining Different Landscapes in a Typical Agricultural Watershed. *Atmosphere* **2023**, *14*, 363. [CrossRef]
8. Qin, M.; Jin, N.; Zhao, J.; Feng, M.; Wang, C. Dynamics of the Response of Vegetation Activity to Air Temperature Change in Temperate China. *Atmosphere* **2022**, *13*, 1574. [CrossRef]
9. Li, Z.; Wu, Y.; Wang, R.; Liu, B.; Qian, Z.; Li, C. Assessment of Climatic Impact on Vegetation Spring Phenology in Northern China. *Atmosphere* **2023**, *14*, 117. [CrossRef]
10. Zhou, Y.; Zhu, X.; Guo, W.; Feng, C. Effects of Climate Change on Wheat Yield and Nitrogen Losses per Unit of Yield in the Middle and Lower Reaches of the Yangtze River in China. *Atmosphere* **2023**, *14*, 824. [CrossRef]
11. Bandira, P.N.A.; Tan, M.L.; Teh, S.Y.; Samat, N.; Shaharudin, S.M.; Mahamud, M.A.; Tangang, F.; Juneng, L.; Chung, J.X.; Samsudin, M.S. Optimal Solar Farm Site Selection in the George Town Conurbation Using GIS-Based Multi-Criteria Decision Making (MCDM) and NASA POWER Data. *Atmosphere* **2022**, *13*, 2105. [CrossRef]
12. Ardiyani, E.; Nurdiati, S.; Sopaheluwakan, A.; Septiawan, P.; Najib, M.K. Probabilistic Hotspot Prediction Model Based on Bayesian Inference Using Precipitation, Relative Dry Spells, ENSO and IOD. *Atmosphere* **2023**, *14*, 286. [CrossRef]