Preface to the Special Issue: Climate Change and Variability of Tropical Cyclone Activity[※]

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Tropical cyclones (TCs) are one of the most destructive natural phenomena on Earth in terms of human-life and economic losses. It is currently a matter of prodigious public and scientific interest how TC activity has changed and will change in a warming climate. This special issue focuses on a challenging subject raised in the Intergovernmental Panel on Climate Change (IPCC) report and numerous research papers. Determining the response of TC activity to climate change is complicated by inherent natural variability. A portion of the detected trends in TC activity likely results from natural variability, but separating that portion is difficult due to limited historical records. Thus, understanding natural variability is critical to the projection of TC activity in a warming climate. In addition, understanding natural variability is also essential for seasonal forecasting.

TC activity, including TC formation, tracks, intensity change, and the associated precipitation, exhibits fluctuations on the interannual, interdecadal, and multidecadal time scales, which are closely associated with multiscale variations of atmospheric and oceanic circulations. Although climate change and variability of TC activity presumably result from environmental control, the associated mechanisms are still a hot topic of scientific research. This special issue solicited a total of 11 articles, covering a wide range of research topics on TC activity. The published papers in this special issue provide valuable insights into the challenging research on climate change and the variability of TC activity.

Two articles in the special issue are on the long-term trend of landfalling TCs. Liu and Chan (pp. 222–234) examine rapid intensification (RI) of landfalling TCs in East Asia and find an increasing trend in the annual number of TCs with landfalling RI over the period 1975–2020. Chen et al. (pp. 304–319) indicate that TC landfalling locations shifted northward during 1979–2018 along with a decreasing/increasing proportion of westward/northward TC tracks due to significantly weakened westward steering flow in the tropical central Pacific around the locations of formation and early development of the westward TCs.

Two articles are related to TC precipitation. Li and Zhao (pp. 320–332) examine the spatiotemporal distribution of TC extreme rainfall (TCER) in China during 1960–2019. They find large regional differences in the threshold for TCER in China, which decrease from the southeastern coast to the northwest inland, with the maximum precipitation (578 mm) being about 35 times higher than the minimum (16.1 mm). Tian et al. (pp. 272–283) evaluate the typhoon regional heavy precipitation event (TRHPE). TRHPEs contribute as much as 20% of the Regional Heavy Precipitation Events (RHPEs), and

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the frequency and the extreme intensity of TRHPEs display increasing trends during 1960–2018.

There are three articles on the interannual variability of TC activity. Zhan et al. (pp. 235–248) examine the impact of the tropical easterly jet (TEJ) on the interannual variability of TC genesis frequency over the western North Pacific (WNP) in the TC season (June–September) during 1980–2020. They find a significant positive correlation between TC genesis frequency over the WNP and the jet intensity in the entrance region of the TEJ over the tropical western Pacific. Dai et al. (pp. 344–353) show that the global tropical storm day (TSD) count exhibits pronounced interannual (3–6 years) and decadal (10 years) variations over the past five-to-six decades without a significant trend. The interannual and decadal leading modes are primarily linked to El Niño–Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO), respectively. Lu et al. (pp. 260–271) demonstrate that observed interannual variations of the frequency of intense hurricanes during the period 1958–2017 are dynamically consistent with changes in the large-scale ocean/atmosphere environment. Track changes can account for ~50% of the interannual variability of intense hurricanes.

Two articles investigate the influence of TC activity on atmospheric circulation. Ling and Lu (pp. 249–259) investigate the contribution of TCs to the East Asia–Pacific (EAP) teleconnection pattern. During summers of strong convection over the tropical WNP, TC days correspond to a stronger cyclonic circulation anomaly over the WNP in the lower troposphere, an enhanced seesaw pattern of negative and positive geopotential height anomalies over the subtropical WNP and midlatitude East Asia in the middle troposphere, and a more northward shift of the East Asian westerly jet in the upper troposphere. Ha et al. (pp. 333–343) conduct an observational analysis of the contribution of WNP TCs to synoptic-scale transient eddy activities (STEA) over the North Pacific during the boreal autumn and early winter during the period 1979–2019, concluding that the WNP TCs entering the midlatitudinal North Pacific provide significant positive effects on the pentad mean strength of STEA.

One article is on the projection of TC activity, and one article is a review on the effect of climate change on TC intensity. Wu et al. (pp. 284–303) investigate future changes in TC activity over the WNP under the representative concentration pathway RCP4.5 with the regional climate model RegCM4. More landfalling TCs are projected over most of the China coast, with an increase of ~18% over the whole Chinese territory. Wu et al. (pp. 205–221) present a review on the understanding of the effect of climate change on basin-wide tropical cyclone intensity, including indices for basin-wide TC intensity, historical datasets used for intensity trend detection, environmental control of TC intensity, detection and simulation of TC intensity change, and some issues on the assessment of the effect of climate change on TC intensity.

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