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• Editorial Notes •

Preface to the Special Issue on the 14th International Conference on Mesoscale Convective Systems and High-Impact Weather※

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A mesoscale convective system (MCS) is an organized cluster of thunderstorms known to be the most important convective mode in causing disastrous high-impact weather, such as heavy rainfall, hail, damaging winds, and tornadoes. The small spatial scale and fast temporal evolution of MCSs make their observation and prediction very challenging. East Asia is home to the world's most prominent monsoon, setting the stage for various severe convective weather events. MCSs and their associated high-impact weather have long been critical issues of concern; as such, their research efforts are valued by governments in East Asia.

The International Conference on MCSs and high-impact weather (ICMCS) is a program initiated by the East Asia Weather Research Association in the late 1990s that is committed to the exchange of research achievements of scientists from East Asia and the United States on MCSs and high-impact weather, extending the understanding of the latest research trends and seeking additional cooperative efforts. The 14th ICMCS was held in Nanjing from 28–30 April 2021, co-organized by Nanjing University, Peking University, and the Chinese Academy of Meteorological Sciences. It provided an opportunity for experts to gather in Nanjing to share their observational and modeling datasets, research methods and tools, and research results that helped improve the understanding and forecasting of MCSs and high-impact weather. This special issue solicited a total of 11 articles covering a wide range of research topics which are briefly introduced below.

Two articles focus on tropical cyclones (TCs) over the Western North Pacific (WNP). Qin et al. (2023b) studied the effect of dropsonde data obtained in field campaigns and conditional nonlinear optimal perturbation (CNOP) sensitivity on TC forecasts. The study suggests that the assimilation of dropsonde data inside sensitive regions of the TC can benefit track and intensity forecasts, which has important implications for targeting observations regarding CNOP sensitivity. Wu and Fang (2023) statistically studied the initial mesoscale vortexes leading to the formation of TCs over the WNP using the ECMWF ERA5 reanalysis data from 1999 to 2018. Three kinds of vortexes were identified, i.e., mid-level vortexes (MV), low-level vortexes (LV), and relatively deep vortexes with notable vorticity in both the lower and middle troposphere (DV), with the latter having the highest TC genesis efficiency. Different large-scale flow patterns were also revealed for these three kinds of vortexes leading to TC genesis.

Three papers researched extreme rainfall in China. Liu et al. (2023a) studied the multiscale combined action and disturbance characteristics of pre-summer extreme precipitation events (EPE) in South China between 1998 and 2018. The majority (63%) of the 67 identified EPEs were characterized by multiscale combined modes of synoptic and low-frequency bands of 10–20-d (quasi-biweekly), 15–40-d (quasi-monthly) and 20–60-d (intraseasonal). While synoptic disturbances ultimately induced the EPEs on the peak wet days, low-frequency disturbances can provide favorable background conditions. Ma and Yao (2023) studied the spatiotemporal characteristics of summer extreme precipitation (SEP) in the key region of the Sichuan-Tibet Railway using daily rain-gauge observations and ERA5 reanalysis from 1979–2020. The SEP in the central-western key region is less intense but more frequent than in the eastern key region. The regional variation of the SEP amount was closely related to the 500-hPa circulation pattern. Jiao et al. (2023) derived a new form of a generalized vertical

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motion equation ($\boldsymbol{Q}_z$) and a generalized omega equation ($\boldsymbol{Q}_p$) in a cartesian coordinate system (nonhydrostatic equilibrium) and an isobaric coordinate system (hydrostatic equilibrium), respectively, which were then adopted to analyze a heavy rainfall event in southern Xinjiang according to a high-resolution numerical simulation. Both were found to perform better than the classical quasigeostrophic $\boldsymbol{Q}$ vector and nongeostrophic $\boldsymbol{Q}$ vector approaches in indicating the development of a precipitation system.

There are three articles on cloud and precipitation microphysics. Liu et al. (2023b) reviewed the approaches, challenges, and future directions for the parameterization and explicit modeling of cloud microphysics. This review focused on several understudied topics with great potential for further advancing bulk microphysics parameterizations. Also presented were the spectral bin scheme and particle-based scheme for representing explicit microphysics and particle-resolved direct numerical simulation models. Using polarimetric radar observations, Huang et al. (2023) studied the microphysical characteristics and processes of convective features associated with extreme rainfall rates (ERCFs) in the Pearl River Delta region of South China during the pre-summer rainy season. Sub-regional differences were found in the lightning flash rate (LFR) distributions in the regions of high ERCF occurrence frequency. ERCFs with higher and lower LFRs were dominated by more active riming and warm-rain processes, respectively. Nonetheless, raindrop collision and coalescence was the main process for the growth of raindrops in the ERCFs. Li et al. (2023) developed a multi-task learning (MTL) encoder-decoder U-net neural network for nowcasting vertically integrated liquid (VIL) and lightning in convective storms using satellite and radar measurements. The MTL significantly outperformed the single-task learning (STL) model for both lightning and VIL nowcasting. In particular, it performed better for organized convective storms than isolated cells.

Three papers concerned data assimilation and ensemble forecasting. Qin et al. (2023a) studied the effects of assimilating the Fengyun (FY)-3D microwave temperature sounder-2 (MWTS-II) radiance with 3D precipitation detection, which was found to reduce the TC track forecast biases by 4.53% for two typhoon cases. This study preliminarily proved that 3D precipitation detection offers potential added value to increase satellite data utilization. Xu et al. (2023) studied the assimilation of the FY-4A advanced geostationary radiance imager (AGRI) clear-sky radiance data in a regional numerical model as well as its impact on the forecast of the "21·7" Henan extremely persistent heavy rainfall. The addition of AGRI can help improve the simulation of the 24-h cumulative precipitation in both intensity and location. The assimilation of satellite data was able to adjust the vertical and horizontal winds over the ocean by adjusting the atmospheric temperature and humidity, ultimately resulting in a narrower and stronger water vapor transport path to the heavy rainfall center in Zhengzhou. Yang et al. (2023) evaluated the added value of probabilistic nowcasting ensemble forecasts on regional ensemble forecasts, which was constructed using a mixed dynamic-integrated method. The probabilistic nowcasting ensemble prediction system outperformed both the regional ensemble prediction system and the rapid-refresh deterministic nowcasting prediction system in terms of surface weather variables, which can provide more details about the spatial intensity and distribution of meteorological parameters.

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