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Editorial

Editorial for the Topic "A Themed Issue in Memory of Academician Duzheng Ye (1916–2013)"

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This Topic covers a wide range of topics, including atmospheric dynamics and physics, synoptic weather, climate variability, climate change, and remote sensing observations for weather and climate studies. There are a total of 29 research papers and two review papers published in "A Themed Issue in Memory of Academician Duzheng Ye (1916–2013)", comprising 14 in *Atmosphere* [1–14], 2 in *Climate* [15,16], and 15 in *Remote Sensing* [17–31].

The first paper (Lu [1]) presents a chronological overview of Professor Ye's remarkable 79-year research journey, spanning from preparatory years and graduate studies, through pioneering breakthroughs in atmosphere dynamics, to a pivotal transition that encompasses global climate sciences and delves into the intricate interplay of climate change's societal impacts, culminating in a globally influential era, offering a comprehensive portrayal of his lifelong scholarly expedition. These prominent accomplishments encompass pioneering seminal research on the Rossby wave dispersion theory and scale-dependent theory of geostrophic adjustment; the establishment of a new meteorology subdiscipline, Qinghai–Tibetan Plateau meteorology; groundbreaking research on the atmospheric general circulation across East Asia and the globe; and visionary research on global changes and their implications for socioeconomic and ecological welfare.

The following five papers in this themed Topic collectively further explore the impacts of the Qinghai–Tibetan Plateau on shaping weather patterns, climate variability, and climate changes across China, East Asia, and beyond. These contributions exemplify the continuous growth and enrichment of our understanding of Qinghai–Tibetan Plateau meteorology, a subdiscipline founded by Professor Ye. The study of Liu et al. [2] introduces a novel circulation index to characterize the orographic potential vorticity (PV) forcing across the Tibetan Plateau. The PV-based index demonstrates a connection to the interannual variability of the East Asian monsoon. The underlying mechanism for this linkage is the downstream influence of the orographic PV forcing across the Tibetan Plateau through the vertical differential advection of PV, reinforcing upward motions and producing extensive precipitation along the Jianghuai Meiyu front. Liu et al. [3] reveal the frequent occurrence of large-scale Kármán vortex streets on the leeward side of the Tibetan Plateau under the seasonally varying zonal mean flow. These vortex streets significantly impact the timing of the seasonal migration and the strength of the rain band along the Meiyu Front to the east of the Tibetan Plateau. Their findings add to the previously discovered roles of the Tibetan Plateau in shaping the weather and climate in eastern Asia. Huang et al. [4] provide a comprehensive review on the characteristics of the two prominent teleconnection patterns, the East Asia/Pacific (EAP) pattern for meridionally propagating wave trains and the "Silk Road" pattern for zonally propagating wave trains, and their impacts on the

East Asian summer monsoon system and summer precipitation variability in China. This paper also reviews the dynamic processes responsible for interdecadal oscillations of boreal quasi-stationary planetary waves and their impacts on the variability of the East Asian winter monsoon system. The study by Ding et al. [5] found that the Tibetan Plateau is the source region of Rossby waves for synoptical disturbances downstream in boreal summer through both vortex stretching and vorticity advection. The interdecadal variability of the Rossby source over the Tibetan Plateau exerts a significant influence on the variability of precipitation in the Huang-huai River Basin, South Korea, and Japan. Sun and Mu [6] demonstrate the effectiveness of the conditional nonlinear optimal parameter perturbation method in discerning the nonlinear characteristics of terrestrial ecosystems and its utility in identifying physical parameters in ecosystem models that exhibit high sensitivity to climate forcing, consequently addressing sources of significant uncertainties in ecosystem models. Their study areas of ecosystems include the Inner Mongolia region, the north–south transect of eastern China, and the Qinghai–Tibet Plateau region.

The common theme of the next four papers revolves around the presentation of observational and modeling evidence highlighting climate changes across diverse regions and varying temporal scales. The contribution from Liu [7] provides a comprehensive review on the recent progress towards a better understanding of thermohaline instability in observations and model simulations, which is a primary mechanism for abrupt climate change as evidenced in paleoclimate proxy data. Lau et al. [8] investigated changes in the characteristics of tropical extreme precipitation–cloud regimes in response to anthropogenic radiative forcing, pinpointing increases in the surface moisture (temperature) as the key driver leading to enhanced convective instability over tropical oceans (land). The paper by Secor et a. [9] is an observational study that quantifies the change in amplitude of synoptic-scale surface temperature variability across the U.S., finding a surge in the surface temperature variability in the Rockies and surrounding regions but a reduction over low land regions. Zhu et al. [10] report a comprehensive observational study on the seasonal variation of the diurnal cycle of the surface sensible heat flux at different stations over the Tibetan Plateau region, finding that the standard heat transfer coefficient used in models tends to overestimate surface sensible heat flux.

The last four papers published in *Atmosphere* are devoted to new techniques for diagnosing the climate variability of the stratospheric polar vortex using a parametric model of elliptic orbits [11], the development of a four-dimensional variational data assimilation system using a neural network-based machine learning technique [12], improving tropical cyclone track forecasts through assimilating Advanced Microwave Sounding Unit data derived from satellites and large-scale flows derived from a global model [13], and improving surface weather forecasts through applying the Grid-to-Point Deep Learning Error Correction method [14]. The two papers published in *Climate* investigate the impacts of El Niño–Southern Oscillation (ENSO) on the subseasonal variations in the North Atlantic Oscillation (NAO) in winter seasons [15] and how the diversity of ENSO types further complicates the ENSO-NAO relation [16].

The 15 papers published in *Remote Sensing* span a wide range of applications of remote sensing observations. Utilizing high-density PM2.5 stations across eastern China and machine learning models, Li et al. [17] demonstrate the indispensable utility of satellite-derived aerosol optical thickness in accurately estimating surface PM2.5 levels, especially in situations when monitoring sites are sparsely distributed. Via combining satellite-derived vegetation images, meteorological observations, and reanalysis datasets, Mao et al. [18] reveal that the normalized difference vegetation index (NDVI) of the vegetation on the Tibetan Plateau is positively correlated with both the Indian summer monsoon (ISM) and precipitation. The correlation between NDVI and ISM is higher than that between NDVI and precipitation since the ISM can also influence the surface thermal conditions favoring vegetation growth on the Tibetan Plateau. Based on the TRMM and ERA5 datasets, Gao et al. [19] found that the spatial pattern of tropical latent heating (TLH) associated with equatorially symmetric tropical surface temperature (TST) is nearly identical to the spatial pattern of TLH associated with equatorially antisymmetric TST. The results suggest an urgent need for taking a whole-tropics perspective in understanding the variability of tropical air–sea–land system.

The next three papers focus on applications of ground-based and satellite radar observations. The main finding of Teng et al. [20] is that turbulent mixing is an additional cause of clear-air echoes besides atmobios migration in Chinese Doppler S-band Weather Radar (CINRAD/SA) observations in Beijing. Specifically, about 58% of dual-wavelength ratios between the CINRAD/SA S-band and the X-band observations from three X-band dual-polarization (X-POL) radars falls within the range of 18 dB and 24 dB, which is quite consistent with the Villars–Weisskopf turbulence theory. The diurnal variation in clear-air echoes is also associated with turbulent mixing since excessive turbulence mixing weakens clear-air echo signals. Yu et al. [21] explore the utility of a deep learning-based radar echo reconstruction model for accurately monitoring severe convective weather over oceans using Advanced Himawari-8 Imager (AHI) brightness temperature observations. Using the precipitation products derived from the dual-frequency precipitation radar (DPR) onboard the Global Precipitation Measurement core observatory (GPM) satellite, Wang et al. [22] conducted a composite analysis of the precipitation structures and microphysical properties in 6432 cases of the northeastern China cold vortex (NCCV) from 2014 to 2019. Their main conclusion is that the precipitation associated with NCCV has a different mechanism for the growth of hydrometeors above and below ~4 km altitude. The lower-level particles grow through collision, whereas the upper hydrometeors grow through the Bergeron process.

The papers [23,24] are on the satellite data assimilation of microwave temperature sounding observations with two different focuses. Zhu et al. [23] improve the methodology for assimilating long-existing instruments in a research data assimilation system, whereas Li et al. [24] conduct an exploratory study on a newly launched satellite in an operational system. Zhu et al. [23] propose a weighted average hypsometry as an observation space localization method to improve AMSU-A radiance assimilation in an ensemble four-dimensional variational (En4DVar) data assimilation system. As a result, the forecast skill of the En4DVar-initialized model becomes comparable to the 4DVar-initialized forecast skill in the southern extratropics and tropics. Li et al. [24] demonstrate that a direct assimilation of Chinese early-morning polar-orbiting satellite FY-3E Microwave Temperature Sounder-3 (MWTS-3) radiance observations has a positive contribution to the China Meteorological Administration Global Forecast System's (CMA-GFS's) global analysis and forecasts for the Southern Hemisphere.

The next three papers deal with satellite data quality. Chen and Guan [25] assess the quality of observations from the Hyperspectral Infrared Atmospheric Sounder-II (HIRAS-II), which is an infrared hyperspectral instrument onboard the world's first early-morning polar-orbiting satellite FY-3E. They concluded that the performance of the HIRAS-II instrument is consistently stable. The Geostationary Interferometric Infrared Sounder (GIIRS) onboard FY-4A is the first infrared hyperspectral atmospheric vertical sounder onboard a geostationary satellite. Yao and Guan [26] derive atmospheric temperature and humidity profiles under all sky conditions from GIIRS-observed brightness temperatures using three deep machine learning algorithms. As expected, the accuracy of the temperature retrieval, validated against radiosonde observations, is the highest when the field of view is completely clear. Shen et al. [27] apply an iterative principal component analysis method for filling the data gaps of Advanced Microwave Scanning Radiometer (AMSR)-2 C-band data in areas where the effect of radio frequency interference (RFI) is strong and thus removed.

Hu and Zou [28] employ brightness temperature (TB) observations at an infrared channel (10.3 μm) of the Advanced Baseline Imager (ABI) onboard the U.S. 16th Geostationary Operational Environmental Satellite (GOES-16) to directly determine tropical cyclone (TC) center positions as well as the radii of inner (R_{IR}) and outer (R_{OR}) rainbands. The root-mean-square differences for 108 cases between ABI-determined centers and the best track centers are 45.35 and 29.06 km for tropical storms and hurricanes, respectively. Their estimates of R_{IR} and R_{OR} can be used to determine storms' annulus, which is defined as the area of asymmetric rainbands dominated by the azimuthal wavenumbers 1–3 from R_{IR} and R_{OR}.

Aiming at applying satellite data for climate studies, Dong and Zou [29] examine 20 years of observations from 2003 to 2023 from the special sensor microwave imager sounder (SSMIS) onboard Defense Meteorological Satellite Program (DMSP) F16, F17, and F18. F16 was launched on 18 October 2003 and carried the first conical-scanning radiometer SSMIS that combines the special sensor microwave/imager (SSM/I), the special sensor microwave/temperature sounder (SSM/T), and the special sensor microwave/water vapor sounder (SSM/T2) together. Having access to nearly two decades of F16 SSMIS data offers abundant opportunities for studying the atmosphere at both the synoptic and decadal scales. Unfortunately, data noise of complicated structures occurred in brightness temperature (TB) observations at the lower atmospheric sounding (LAS) channels since 25 March 2013. Due to noise interference, TB observations reflecting rain, clouds, tropical cyclone warm core, temperature and water vapor distributions are not readily distinguishable, especial in channels above the middle troposphere (channels 4–7 and 24), whose dynamic ranges of TB are smaller than low tropospheric channels 1–3. Dong and Zou [29] not only found that the data noise is around 1–2 K, occurs at certain cross-track wavelengths, and has a latitudinal variation, but also developed an effective noise mitigation scheme. It was shown that TB observations from conical-scanning radiometer SSM/T can directly capture hurricane 3D structures. We may also investigate the decadal change in many features of tropical cyclones derivable from these TB observations once the noise in F16 SSMIS LAS channels from April 25 to the present are eliminated.

The second-to-last paper is on oceanic remote sensing data. Liu et al. [30] conducted a study to find the decorrelation length scale of background errors is a key factor for the two-dimensional variational method (2D-Var) to generate multi-satellite merged maps of altimeters with an effective resolution capable of capturing meso-scale eddies in the ocean. They conclude that having a higher proportion of small-scale signals and a smaller proportion of large-scale dynamic signals result in a smaller decorrelation length scale of background errors and thus a higher effective resolution of the merged altimeter data.

Finally, the paper from Zhao et al. [31] conducts an observation-based investigation of the dynamics and microphysical characteristics of the extreme heavy rainfall on 20 July 2021 in Zhengzhou, China. The record-breaking hourly rainfall of 201.9 mm caused severe urban flooding and human casualties. The synoptic flow was characterized by an erect updraft at the low levels and an enhanced easterly inflow, which brought abundant moisture from the oceans and converged at Zhengzhou. A slow-moving convective storm persisted for an hour-long time over Zhengzhou and produced the extreme rainfall. The disdrometer data reveal unusually high concentrations of all sizes of raindrops with both maritime and continental convection properties, and the polarimetric radar data confirm the important contributions of both ice-based and warm rain processes. Therefore, the extremely heavy rainfall resulted from an interaction among convective-scale, mesoscale dynamics and microphysical processes under favorable synoptic conditions.

In conclusion, many novel developments and advances in meteorology and oceanography are represented in the publications in this Topic. We hope that this collection of papers will stimulate further research in atmospheric and oceanographic sciences.

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