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Editorial: The Asian Monsoon

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Editorial on the Research Topic

The Asian Monsoon

The Asian monsoon is an essential component of the global climate system (Trenberth et al., 2006). Its evolution and variability can significantly influence the vegetation, populations, economies, and even cultures that inhabit Asian monsoon regions, which prevails from the Indian sub-continent to Southeast and East Asia. The monsoon-related natural hazards, such as flooding, droughts, heatwaves, and blizzards, significantly impact society, and human livelihood (Wang, 2006). Therefore, it is essential to understand the variability and mechanism of *the Asian monsoon* so that skillful forecasts, predictions, and reasonable future projections can be made accordingly.

The Asian monsoon consists of both summer and winter counterparts (Ju and Slingo, 1995; Chang et al., 2006; Wang and Lu, 2017) and several sub-systems, including the Indian monsoon, the East Asian monsoon, and the western North Pacific monsoon (Wang and LinHo, 2002). These sub-systems have strong mutual linkages and vary from synoptic to multidecadal and longer time scales. They interact with the Earth's ocean, land, atmosphere, the biosphere, among others, *via* complex coupled processes (Meehl, 1994; Webster et al., 1998; Gadgil, 2003; Goswami, 2005; Yihui and Chan, 2005; Huang et al., 2007; Ha et al., 2012; Huang et al., 2012; Chen et al., 2019). It is essential to know how and why the current state-of-the-art numerical models capture these processes before making forecasts and predictions. This issue becomes increasingly crucial in light of global climate change.

In this Research Topic, the main objective was to present some recent advances and identify some remaining gaps in our knowledge on all aspects of *the Asian monsoon*. Sixteen papers were published after peer reviews. Most of them focus on the summer monsoon and discuss the role of air-sea interactions in the monsoon variability on the interannual timescale. The El Nino-Southern Oscillation (ENSO) is an essential driver for the Indian summer monsoon (ISM) precipitation (Ju and Slingo, 1995; Gadgil, 2003), and its relationship with the ISM underwent decadal weakening in the late 1970s (Kumar et al., 1999) and recovered recently (Yang and Huang, 2021; Yu et al., 2021). Bódai et al. revisit the unstable ENSO-ISM relationship and the underlying mechanism with the help of large-ensemble simulations and discuss its nonlinearity and nonergodicity. Son et al. further claim the essential role of the ISM precipitation in exciting a dominant teleconnection in boreal summer, the Silk Road pattern (SRP, Lu et al., 2002; Enomoto et al., 2003; Chowdary et al., 2019) by showing how the Rossby wave source is generated by the ISM-related diabatic heating. Although the SRP is an internal mode of the atmosphere (Yasui and Watanabe, 2010), it may be excited or amplified by atmospheric external forcing or resonance (e.g., Yasui and Watanabe, 2010; Wang et al., 2017), leading to longer atmospheric residence time over India and thereby more frequent extreme events (Lakshmi Kumar et al.).

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The influence of ENSO on the East Asian summer monsoon (EASM) is also crucial (Xie et al., 2016; Li et al., 2017; Zhang et al., 2017). It shows significant diversity regarding the spatial patterns of ENSO (Feng et al., 2011; Yuan and Yang, 2012), the decaying speed of ENSO (Chen et al., 2012; Feng et al., 2014; Zhou et al., 2019), the background state (Feng et al., 2014), the different configurations with other oceanic signals (Xie et al., 2009; Chen et al., 2016; Feng et al., 2020), and many others. Zhang et al. further attribute this diversity to the persistence and transition speed of ENSO. Li et al. take Hong Kong as an example and link this diversity to the North Atlantic sea surface temperature. Besides ENSO, J. Xu et al. claim that the Indian Ocean dipole (Saji et al., 1999) can influence the EASM precipitation and thereby the rice yield in Jiangsu, a province in eastern China. You et al. suggest that the thermal state of the tropical western Pacific can change the meridional temperature gradient and the onset of the EASM. Huang et al. reveal that the accumulation effect of the intra-seasonal oscillation over the tropical western Pacific can change the meridional location of the western Pacific subtropical high, a crucial circulation system of the EASM. Zeng et al. suggest that the linkage between the onset dates of the ISM and the EASM strengthened after the late 1970s, which is attributed to the Indian Ocean basin warming. Liu et al. suggest that the Atlantic Multidecadal Variability and its footprint in the Indian Ocean may lead to multidecadal seesaw in the Hadley Circulation's strength between Northern and Southern Hemispheres and further to changes in land precipitation over monsoon regions. Wen et al. reveal the influences of the North Pacific Victoria Mode on the Madden-Julian Oscillation, an essential factor influencing *the Asian monsoon* on the intraseasonal timescale.

Several papers in the Research Topic discuss land-surface processes in the EASM variability, which is another essential aspect for *the Asian monsoon* (Webster et al., 1998; Xue et al., 2004; Yasunari, 2007). Wang et al. review the impacts of the soil freeze-thaw process and snow melting over the Tibetan Plateau on the EASM. Liang et al. report a decadal change in the relationship between the Tibetan Plateau temperature and summer precipitation over the South China Sea. Xu et al. identify a relationship between the Eurasian snow melting in spring and the EASM and suggest the mechanism involving the changes in the baroclinicity and transient eddy forcing. Especially, Lau et al. report a fascinating result on the role of the dust from Middle East deserts in affecting the Asian summer monsoon. They highlight that the dust-cloud-radiation-precipitation dynamical feedback on subseasonal-to-seasonal timescale can lead to anomalous diabatic heating over the Pakistan/Northwest India region and excite atmospheric Rossby waves, which shifts the whole Asian summer monsoon westward.

The Research Topic is overall successful, but it has deficiencies. For example, most of the articles focus on the air-sea interaction aspect of the monsoon on the seasonal timescale and longer. Other processes and timescales, such as the land-atmosphere interactions, internal atmospheric processes, and subseasonal variabilities or extremes, which are also essential for *the Asian monsoon*, were less discussed. There is even no paper on the Asian winter monsoon, an indispensable member of *the Asian monsoon*, and *the Asian monsoon* projection and its uncertainties, an increasing concern of both the scientific community and the public. Although this Research Topic only contains a very small sample size, it reflects the current status of the monsoon research to some extent, and a more balanced study on *the Asian monsoon* in the future is recommended.

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All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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