Challenge of the summer rainfall forecast in China: A possible solution

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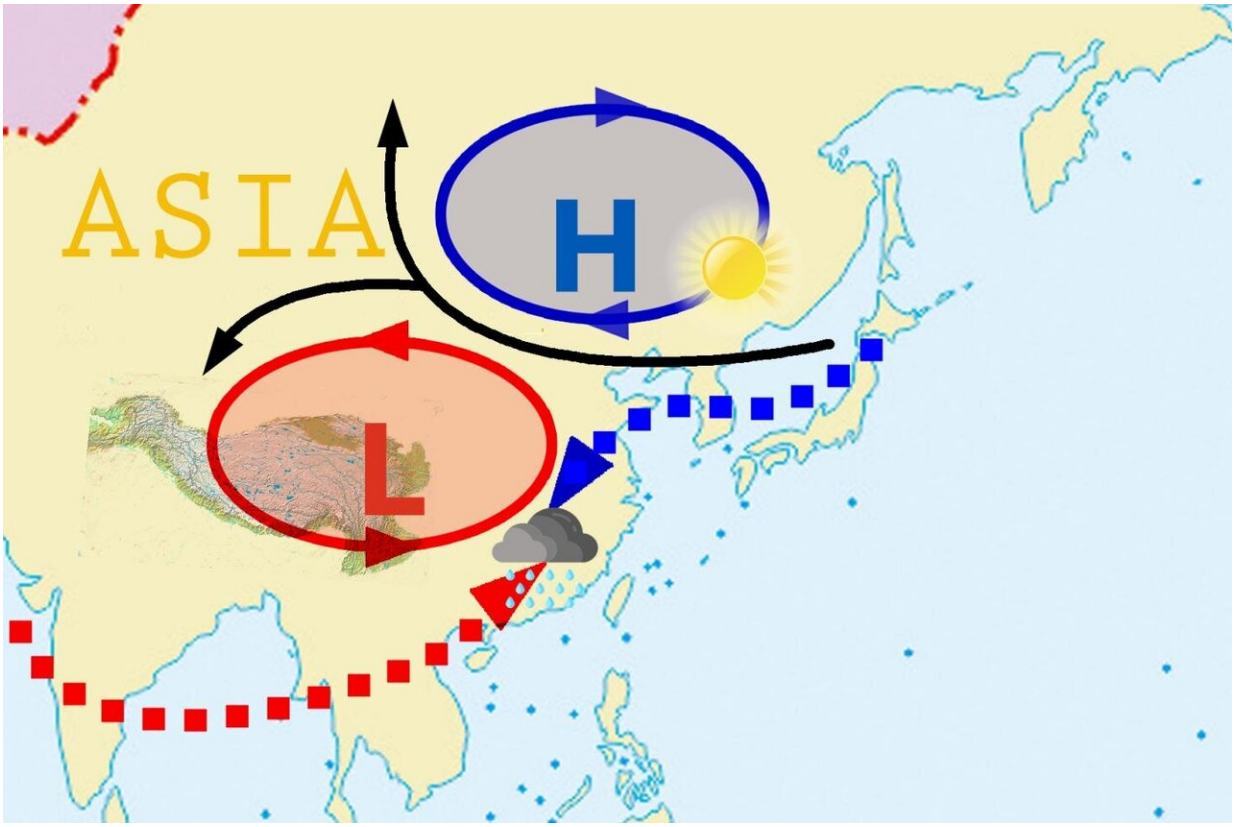

Diagram of the "coupling wheel" between the Mongolian cyclone and the South Asia High that drives the East Asia summer monsoon (EASM). Dashed lines representcirculation anomalies at 850hPa (lower atmosphere) and solid lines show theseanomalies at 200hPa (upper atmosphere) along with the corresponding surface high and low locations. Credit: Congwen Zhu and Michael Joyce

The Mongolian Cyclone is a major meteorological driving force across southeast Asia. This cyclone is known for transporting aerosols, affecting where precipitation develops. Meteorologists are seeking ways to improve seasonal prediction of the relationship between the Mongolian cyclone and the South Asia high. These features are major components of the East Asian summer monsoon (EASM) and the corresponding heavy rain events. New research suggests that analyzing these phenomena in the upper-level atmosphere will enhance summer rainfall forecasting skills in China.

"The lower seasonal predictability of EASM may happen when the coupling wheel of Mongolian cyclone and South Asia high prevails over East Asia." said Prof. Congwen Zhu, who leads the season-to-season (S2S) research team at the Institute of Climate System, Chinese Academy of Meteorological Sciences. He and his S2S team just published a journal entry in *Advances in Atmospheric Sciences* highlighting how the EASM presents a significant challenge to forecasting rain.

The EASM features a three-dimensional circulation, affecting many layers of the atmosphere. When the Mongolian cyclone is coupled with the South Asia high, it is a complex system that causes rainfall to vary between seasons through the year. This variability pattern across East Asia interests meteorologists who want to improve their ability to forecast seasonal rainfall and year-to-year changes.

The S2S team also analyzed how sea surface temperatures (SST) influenced summer rainfall anomalies in China using data between 1979-2015. In the majority of cases, results show a weak connection between southeast Asian precipitation and the dominant SST anomalies in the tropical Pacific, the Indian Ocean, and the North Atlantic Ocean.

Dr. Zhu and his colleagues found that the coupling between the

Mongolian cyclone over north Asia and the South Asian high near the Tibetan Plateau had a greater influence on seasonal rainfall than SST anomalies during 1979-2015. The notable interaction between these two circulations occurs in the upper troposphere, nearly 10 km above the surface, at an average pressure of 200 hPa.

Another prominent influence exists between the tropical low-level western Pacific high and upper-level South Asian high via the east-west wind flow over southeast Asia. This second "coupling wheel," according to Dr. Zhu, dominated the seasonal rainfall anomalies in the middle-lower reaches of Yangtze River. With this new data, his team achieved higher rainfall predictability linking their data with the external tropical forcing of El Niño-Southern Oscillation (ENSO).

Despite this, the coupling between Mongolian cyclone and the South Asian high occurs more frequently, illustrating the summer rainfall forecasting challenges throughout China. In studies using both 24-year and 7-year datasets, results show that this cyclone/anticyclone (low/high pressure) interaction accounts for about 66% of seasonal rainfall anomalies in China.

More information: Congwen Zhu et al, Diversity of the Coupling Wheels in the East Asian Summer Monsoon on the Interannual Time Scale: Challenge of Summer Rainfall Forecasting in China, *Advances in Atmospheric Sciences* (2021). DOI: 10.1007/s00376-020-0199-z

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