New study evaluates uncertainties in modeling El Niño-related changes in atmospheric circulation

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A research team from the Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences has examined the performance of eight

prominent reanalysis datasets in capturing regional Hadley Circulation (HC) responses to El Niño–Southern Oscillation (ENSO) events.

The researchers found that while they accurately represented the spatial pattern of circulation anomalies during El Niño events, the magnitudes of these changes could vary by up to a factor of 2.7 between different reanalyses. The study was published in *Advances in Atmospheric Sciences* on June 13.

ENSO, as a dominant mode of global interannual variability, influences the intensity and meridional extension of the Hadley Circulation, which plays a crucial role in shaping weather patterns worldwide.

While previous studies have focused on assessing the global HC using zonal-mean mass stream function, this study takes a regional perspective by adopting a newly developed technique to construct the three-dimensional structure of HC.

The results demonstrated that all eight reanalysis datasets reproduced the spatial structure of HC responses to ENSO events. Notably, an intensified HC was observed in the central-eastern Pacific, accompanied by weakened circulations in the Indo-Pacific warm pool and tropical Atlantic. The high spatial correlation coefficient among each pair of these eight datasets validated the consistency in capturing the spatial patterns of HC anomalies.

However, the study also revealed significant uncertainties in the amplitude of HC responses across the datasets. In particular, the variability of equatorially asymmetric HC anomalies associated with ENSO events exhibited substantial differences, with the Climate Forecast System Reanalysis (CFSR) showing approximately 2.7 times greater amplitude compared to the Twentieth Century Reanalysis (20CR).

CFSR is a third generation global, high-resolution, coupled atmosphere-ocean-land surface-sea ice system designed to provide the best estimate of the state of these coupled domains over 1979–2009, while 20CR is a comprehensive global atmospheric circulation data set spanning 1850–2014.

"These findings caution us about the limitations and potential biases when using reanalysis data to evaluate the intensity of ENSO-related HC anomalies," said Li Xichen, corresponding author of the study. "Understanding these uncertainties will guide future investigations and improve our ability to evaluate the impacts of ENSO on regional climates."

More information: Yadi Li et al, Uncertainties of ENSO-related Regional Hadley Circulation Anomalies within Eight Reanalysis Datasets, *Advances in Atmospheric Sciences* (2023). DOI: 10.1007/s00376-023-3047-0

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