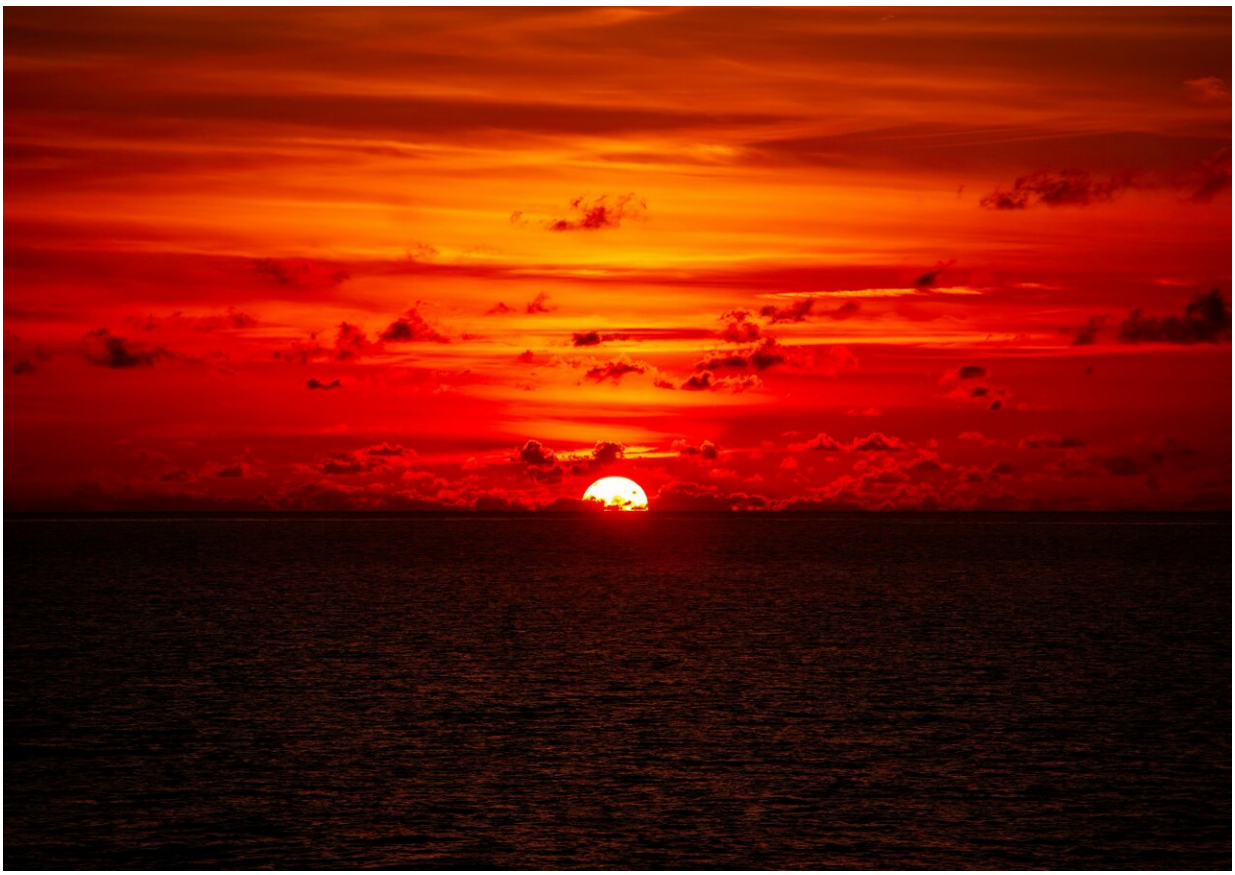
Scientists identify the predictability limit of oceanic mesoscale eddy tracks in the South China Sea

July 30 2024



Credit: Unsplash/CC0 Public Domain

Oceanic mesoscale eddies (OMEs) are swirling water structures that play

a crucial role in ocean dynamics. These eddies transport heat, salt, nutrients, and other materials across the ocean, significantly influencing marine ecosystems and global climate patterns. Despite their importance, predicting the trajectories of these eddies remains challenging.

A team of scientists from the Institute of Atmospheric Physics (IAP) at the Chinese Academy of Sciences (CAS), Zhejiang University, Beijing Normal University and Laoshan Laboratory, utilized several datasets of mesoscale eddy observations combined with the nonlinear local Lyapunov exponent (NLLE) method to estimate the theoretical predictability limit of mesoscale eddy trajectories.

"Studying these eddies helps us better understand the complexity of eddy movements, the relationship between eddy motion, and the characteristics of the eddy itself and its surroundings. We classified and discussed the differences in predictability under various factors, considering the diverse characteristics of mesoscale eddies and the seasonal traits of the South China Sea.

"This comprehensive approach aims to enhance our understanding of how different mesoscale eddies and environmental conditions affect predictability limit," said Prof. Liu Hailong, the lead author of the study.

"By predicting the behavior of these eddies, we can more effectively provide security for economic and transport activities in the ocean."

The study revealed several key insights. Firstly, the mean predictability limit of cyclonic eddy (CE) tracks is approximately 44 days, while anticyclonic eddy (AE) tracks have a predictability limit of around 39 days in the South China Sea. These values varied slightly across different datasets, indicating a robust predictability range. Long-lived, high-amplitude, and large-radius eddies exhibit predictability limits exceeding 60 days. In contrast, short-lived, low-amplitude, and small-radius eddies

have predictability limits of around 40 days.

A complexity index (CI) was introduced to elucidate the complexity of OME tracks further. The findings suggest that long-lived, high-amplitude eddies, mainly located on the northern slope of the SCS and the west of Luzon Strait, have simpler and smoother tracks.

"The South China Sea is one of the most complex and dynamic sea areas in the world and is significantly influenced by the monsoon. Its seasonal characteristics also have a profound influence on the formation, development, and movement of mesoscale eddies," according to the study.

AE tracks are most predictable in autumn, with a limit of 52 days, while CE tracks are most predictable in winter, reaching up to 53 days. Conversely, summer presents the lowest predictability for both types of eddies. The locations of more predictable eddy tracks tend to overlap with periodic eddies, so the predictability limits of periodic eddies warrant specific discussion.

Periodic eddies are regular eddies in the South China Sea, often generated at fixed times and locations, typically annually. These periodic eddies, which are usually long-lived and stronger, exhibit a predictability limit of 49 days for both CE and AE tracks. They are predominantly located east of the Luzon Strait and along the west coast of Luzon Island.

"By determining the predictability limit, scientists can identify the strengths and limitations of current ocean models. This insight helps refine these models, leading to better simulations of the ocean and more accurate predictions," said Prof. Liu. "This provides us with a new research perspective to help us better understand and predict ocean eddy tracks."

These findings have recently been published in the *Advances in Atmospheric Sciences*.

More information: Hailong Liu et al, The Predictability Limit of Oceanic Mesoscale Eddy Tracks in the South China Sea, *Advances in Atmospheric Sciences* (2024). DOI: 10.1007/s00376-024-3250-7

Provided by Chinese Academy of Sciences