How LangYa 2.0 will change the future of marine forecasting

The Innovation Water News Team*
*Correspondence: water@the-innovation.org
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When the Institute of Oceanology, Chinese Academy of Sciences (IOCAS) unveiled LangYa 2.0 in Qingdao on June 6, the launch did not attract the same public attention as popular AI chatbots or weather models first. Yet within the ocean science community, many researchers viewed it as a potentially important milestone, namely one of the first attempts to move marine forecasting beyond predicting the state of the ocean and toward forecasting the marine events that directly affect human activity.

Developed by the IOCAS, LangYa 2.0 is a marine forecasting system based on latest AI technology. Unlike its predecessor and similar models that focused on ocean variables such as temperature, salinity and currents, the new version is designed to predict six categories of marine phenomena, including typhoons, storm surges, extreme rainfall, mesoscale eddies, internal solitary waves, and Arctic sea ice.

According to Li Xiaofeng, a researcher at the IOCAS who co-led the LangYa 2.0 development team with Wang Fan, the name of the model is derived from the ancient Chinese concept. The name refers to the historic Langya Terrace in Qingdao, where ancient Chinese astronomers observed celestial changes and seasonal cycles. The researchers see their AI system as a modern continuation of that tradition of observing nature to understand and anticipate change, he said.

Figure 1. Evolution of the large ocean model from LangYa 1.0 to LangYa 2.0 LangYa 1.0 forecasts ocean-state variables, including temperature, salinity, density, and currents, whereas LangYa 2.0 forecasts ocean phenomena, including typhoons, internal waves, and eddies, etc.

What makes LangYa 2.0 noteworthy is not simply that it is another AI forecasting model, on which the global race is already highly crowded. In atmospheric science, systems such as Google's GraphCast, Huawei's Pangu and Fudan University's FuXi have demonstrated that AI can rival or even surpass some traditional numerical forecasting approaches in speed and accuracy. Ocean forecasting has also seen the emergence of data-driven systems such as XiHe, WenHai, Artificial Intelligence Global Ocean Modeling System (AI-GOMS) and LangYa 1.0 itself.

The difference, according to LangYa's developers, lies in the model's attempt to forecast not only what's happening inside the ocean, but also its behavior logic behind. "For decades, ocean forecasting has largely followed the same logic as weather forecasting," Li told *The Innovation*, "Researchers observe the current state of the ocean, including variables such as sea-surface temperature, salinity, pressure and currents, and then use physical equations or AI models to predict how these variables will evolve."

This approach remains scientifically essential, he said. Without accurate estimates of ocean conditions, no forecasting system can operate. LangYa 1.0, released in late 2024, represented a major advance in this direction by creating a foundation model capable of predicting key ocean variables across multiple spatial and temporal scales.

Yet, Li argued that ocean forecasting faces a challenge that differs fundamentally from weather forecasting. "Most people care about weather because it directly affects daily life. They want to know whether it will rain tomorrow or whether temperatures will drop next week", he said, "However, few members of the public care whether ocean salinity in a particular region rises by a fraction of a unit, or whether a current becomes slightly stronger. These variables matter scientifically, but their societal significance is indirect".

It's governments, industries, and coastal communities that care about these events. They need to know whether a typhoon will rapidly intensify before landfall, whether a storm surge will inundate a coastal city, whether a new shipping route can be opened through Arctic sea ice, and whether internal solitary waves will threaten offshore infrastructure.

"In other words, the most economically important questions are not about the ocean's current state but about its future behavior — and that insight became the foundation of LangYa 2.0", Li said.

Rather than stopping at environmental variables, the team developed six specialized models built on a global marine foundation model, the result of which is a "1+6" architecture, or one ocean foundation model coupled with six phenomenon-oriented forecasting systems, as shown in Figure 1.

Compared with the construction of a building, the foundation model provides a comprehensive understanding of the marine environment, while the specialized models focus on specific high-impact events.

Li said the distinction may seem subtle, but he believed it has profound implications for how AI is applied in Earth sciences.

A NEW FRONTIER FOR OCEAN AI

For long, weather forecasts affect billions of people on a daily basis and therefore attract substantial investment from governments, research institutions and technology companies. Marine forecasting, by comparison, has traditionally served a more specialized group of users, including shipping operators, offshore energy companies, fisheries managers, coastal authorities and defense organizations. As a result, much of the global investment in AI forecasting over the past decade has focused on the atmosphere rather than the ocean.

That situation might be changed with LangYa 2.0 (Figure 1). As climate change continues to reshape the world's oceans, demand for advanced marine forecasting capabilities is growing rapidly. More intense tropical cyclones, rising sea levels, expanding offshore energy development and increasing interest in Arctic shipping routes are creating new requirements for accurate and timely ocean predictions.

The Arctic illustrates this trend particularly well. According to IOCAS, LangYa 2.0's sea-ice forecasting model ranked first among several international forecasting systems in predicting the September Arctic sea-ice extent in 2025, based on independent evaluations. The model can produce monthly forecasts at a spatial resolution of three kilometers, offering valuable support for future polar navigation and maritime planning.

The offshore engineering represents another important application area. Internal solitary waves, which occur beneath the ocean surface and are often difficult to detect, can pose significant risks to offshore platforms, underwater infrastructure and marine engineering operations. By identifying and forecasting such events weeks in advance, AI-based systems such as LangYa 2.0 could help improve operational safety and reduce economic losses.

More importantly, the project points to a future in which marine forecasting becomes increasingly interdisciplinary. According to the development team, future versions may integrate ocean physics with ecology, fisheries science, aquaculture, harmful algal bloom monitoring, and environmental management. The goal is not only to forecast changes in the ocean but also to better understand how those changes affect ecosystems, industries, and human societies.

Such ambitions will not be easily achieved. Predicting physical ocean processes is already a complex task, while forecasting biological and ecological responses introduces additional layers of uncertainty. Nevertheless, many researchers believe this is the direction in which the field is moving.

In marine science, the transition from forecasting variables to forecasting phenomena may mark the beginning of a new stage in the development of ocean intelligence.

DECLARATION OF INTERESTS

The author declares no competing interests.