New statistical models could lead to better predictions of ocean patterns

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The world's oceans cover more than 72 percent of the earth's surface, impact a major part of the carbon cycle, and contribute to variability in global climate and weather patterns. However, accurately predicting the condition of the ocean is limited by current methods. Now, researchers at the University of Missouri have applied complex statistical models to increase the accuracy of ocean forecasting that can influence the ways in which forecasters predict long-range events such as El Nińo and the lower levels of the ocean food chain—one of the world's largest ecosystems.

"The ocean really is the most important part of the world's environmental system because of its potential to store carbon and heat, but also because of its ability to influence major atmospheric weather events such as droughts, hurricanes and tornados," said Chris Wikle, professor of statistics in the MU College of Arts and Science. "At the same time, it is essential in producing a food chain that is a critical part of the world's fisheries."

The vastness of the world's oceans makes predicting its changes a daunting task for oceanographers and climate scientists. Scientists must use direct observations from a limited network of ocean buoys and ships combined with satellite images of various qualities to create physical and biological models of the ocean. Wikle and Ralph Milliff, a senior research associate at the University of Colorado, adopted a statistical "Bayesian hierarchical model" that allows them to combine various sources of information as well as previous scientific knowledge. Their method helped improve the prediction of sea surface temperature extremes and wind fields over the ocean, which impact important features such as the frequency of tornadoes in tornado alley and the distribution of plankton in coastal regions—a critical first stage of the ocean food chain.

"Nate Silver of The New York Times combined various sources of information to understand and better predict the uncertainty associated with elections," Wikle said. "So much like that, we developed more sophisticated statistical methods to combine various sources of data—satellite images, data from ocean buoys and ships, and scientific experience—to better understand the atmosphere over the ocean and the ocean itself. This led to models that help to better predict the state of the Mediterranean Sea, and the long-lead time prediction of El Nińo and La Nińa. Missouri, like most of the world, is affected by El Nińo and La Nińa (through droughts, floods and tornadoes) and the lowest levels of the food chain affect us all through its effect on Marine fisheries."

El Nińo is a band of warm ocean water temperatures that periodically develops off the western coast of South America and can cause climatic changes across the Pacific Ocean and the U.S. La Nińa is the counterpart that also affects atmospheric changes throughout the country. Wikle and his fellow researchers feel that, through better statistical methods and models currently in development, a greater understanding of these phenomena and their associated impacts will help forecasters better predict potentially catastrophic events, which will likely be increasingly important as our climate changes.

More information: Wikle's study, "Uncertainty management in coupled physical-biological lower trophic level ocean ecosystem models," was funded in part by the National Science Foundation and was published in *Oceanography and Statistical Science*.