A surprising range of climate events may be predictable years in advance

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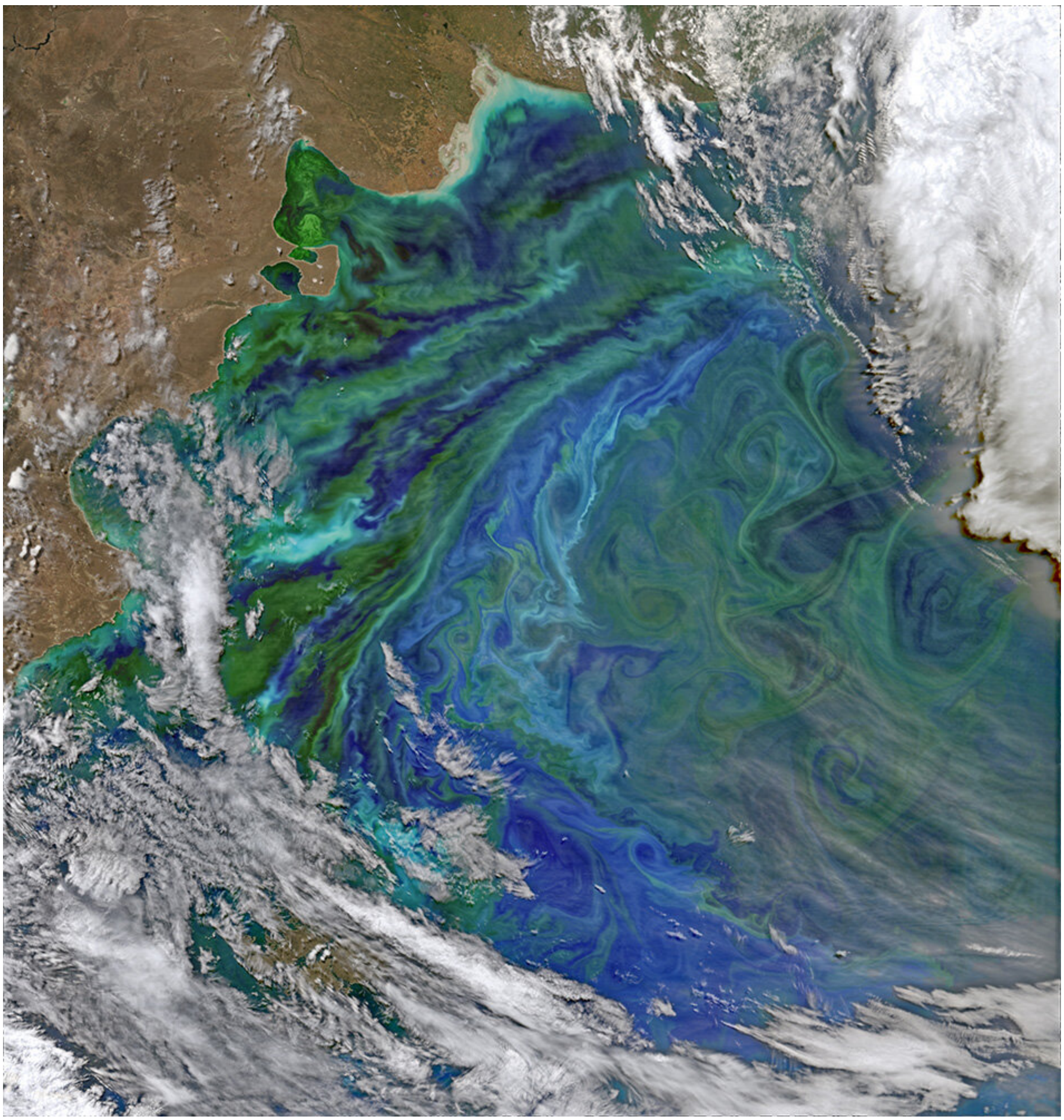

Colorful phytoplankton in the waters off the coast of Patagonia in South America. For many regions of the ocean, net primary productivity – a measure of the organic matter produced by phytoplankton – can be predicted one to three years in advance. Such predictions could help sustainably manage coastal marine ecosystems. Credit: NASA

An increase in the likelihood of a "Greenland Block"—a bulge of high pressure that stalls over the massive island and can cause extreme weather both in North America and Europe—could be predictable years in advance.

So too could changes in ocean acidity in the California Current System, which sustains rich and economically important fisheries, as well as fluxes in the amount of organic matter produced by phytoplankton in the ocean, which forms the base of the marine food pyramid.

Even probable increases or decreases in the amount of carbon dioxide taken up by plants, and the resulting impacts on the concentration of carbon dioxide in the atmosphere, may be predictable several years out.

These findings come from a slew of new papers that collectively show that a wide range of phenomena across the atmosphere, oceans, and land may be predictable on time horizons that stretch from a year to a decade out. The new studies are all derived from the Decadal Prediction Large Ensemble (DPLE), a massive, freely available database of model simulations developed and housed at the National Center for Atmospheric Research (NCAR).

The DPLE was designed and created specifically to allow scientists from across disciplines to probe for aspects of the Earth system that might have elements of predictability on a decadal time scale, bridging the gap between seasonal forecasts and climate projections. So far, it has confirmed some elements that scientists already suspected could be predicted years in advance—such as sea surface temperatures in the North Atlantic, which influence weather over Europe among other things. But examining the data trove has also uncovered a host of other possibilities.

"It's been two years since we've released the dataset, and what we've learned has exceeded our expectations," said NCAR scientist Steve Yeager, who led the project. "Things people never thought were predictable, we're finding predictable with DPLE."

25,600 Simulated Years

DPLE's secret to success is its size. The dataset comprises 64 individual ensembles (or sets of simulations), one for every year between 1954 and 2017. Each ensemble consists of 40 members running forward a decade in simulated time. In total, the dataset contains 25,600 simulated years of climate information. The simulations were created by the NCAR-based Community Earth System Model (CESM) and run primarily on the NCAR-Wyoming Supercomputing Center's Cheyenne system.

Having an ensemble of 40 individual model simulations of the same decade allows scientists to tease out delicate signals of predictability that would otherwise be missed with just one—or even a handful—of model runs. Each member of the ensemble is kicked off using historic conditions for the starting year, but then each is also tweaked a nearly indistinguishable amount. The minuscule adjustment is enough to send each simulation off on a distinct path, resulting in 40 possible ways the decade's climate could have unfolded.

Scientists can uncover possible areas of predictability by looking across the entire ensemble. Areas where the simulations tend to agree are candidates for predictability, and the stronger they agree, the more skillful the prediction is likely to be.

"We were the first to work on decadal prediction using a large ensemble in a single-model system," Yeager said. "The fact that we threw all these ensemble members at the problem is what allowed us to get these results."

The success of the project already has Yeager and his colleagues considering what's next. One possibility is tweaking the types of observations used to start the ensemble. Because phenomena that can be predicted years in advance tend to be tied to changes in the ocean—which play out over much longer time scales than changes in the atmosphere and on land—the original DPLE used the state of the ocean and sea ice as the starting point for the models. Adding observations of the atmosphere and land could improve some predictability in the relatively near term of more than a year or so.

"We're really interested in how to advance this—what we could do that would take it to the next level," Yeager said. "The first DPLE is providing us hints of what's possible. Now we want to fine-tune the techniques needed to make decadal predictions something that could be useful to decision-makers and planners."

More information: Panos J. Athanasiadis et al. Decadal predictability of North Atlantic blocking and the NAO, *npj Climate and Atmospheric Science* (2020). DOI: 10.1038/s41612-020-0120-6

Riley X. Brady et al. Skillful multiyear predictions of ocean acidification in the California Current System, *Nature Communications* (2020). DOI: 10.1038/s41467-020-15722-x

Nicole S Lovenduski et al. High predictability of terrestrial carbon fluxes from an initialized decadal prediction system, *Environmental Research Letters* (2019). DOI: 10.1088/1748-9326/ab5c55

Isla R. Simpson et al. Decadal predictability of late winter precipitation in western Europe through an ocean–jet stream connection, *Nature Geoscience* (2019). DOI: 10.1038/s41561-019-0391-x

K. M. Krumhardt et al. Potential Predictability of Net Primary Production in the Ocean, *Global Biogeochemical Cycles* (2020). DOI: 10.1029/2020GB006531

Stephen Yeager. The abyssal origins of North Atlantic decadal predictability, *Climate Dynamics* (2020). DOI: 10.1007/s00382-020-05382-4

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