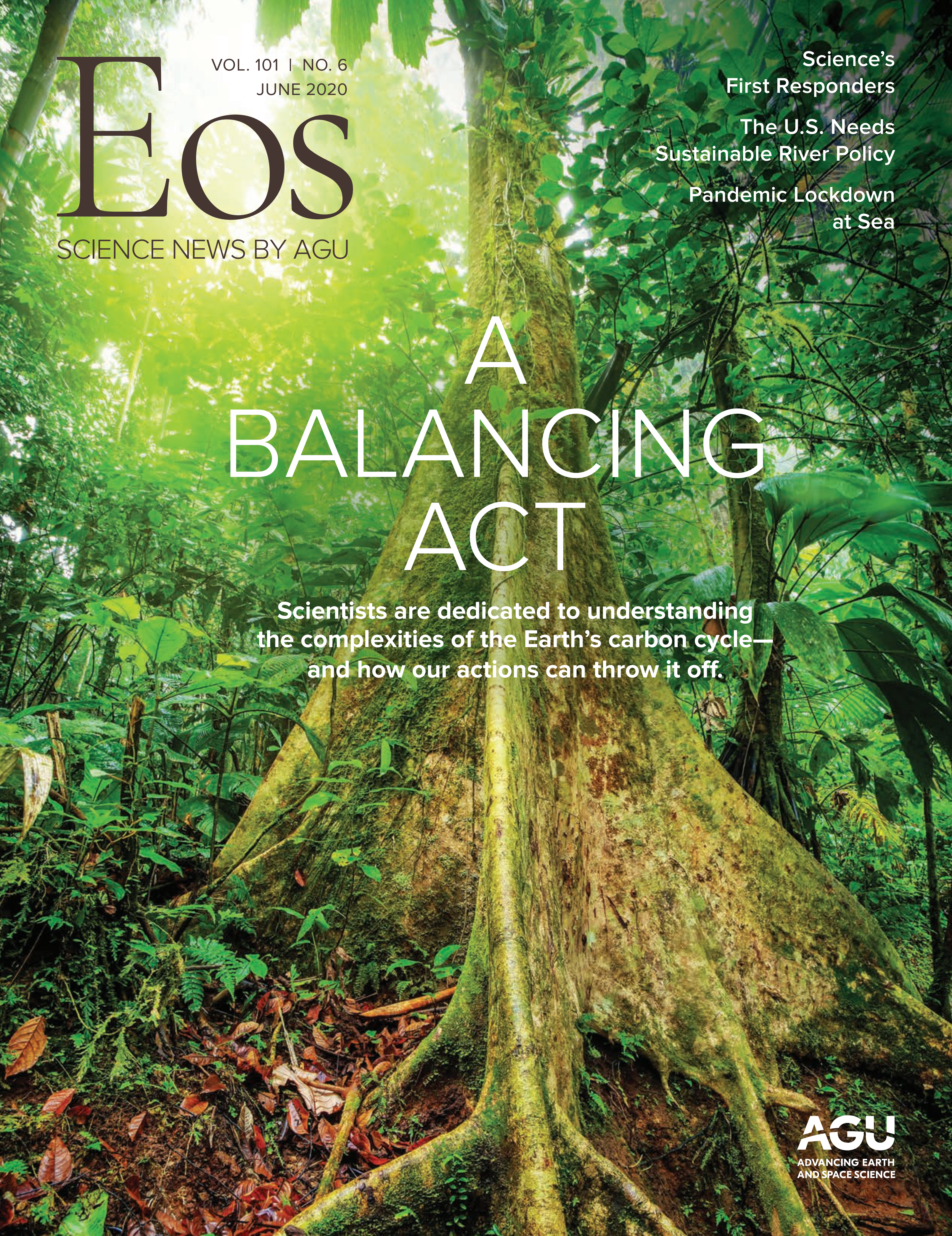

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The Stuff That Psyche Is Made Of

Psyche is a large, peculiar asteroid that orbits the Sun in our solar system's asteroid belt. Although most asteroids are made primarily of rock or ice, Psyche is abundant in metal, suggesting that it could be the remnant core of an early planet. Now *Elkins-Tanton et al.* report that Psyche may have a higher ratio of rock to metal than previously hypothesized.

In preparation for a NASA mission to Psyche set to launch in 2022, the researchers reviewed and analyzed reports on the latest observations of the asteroid, which included data from mass and volume calculations, radar measurements, and investigations of Psyche's spectral signature.

The analysis suggests that Psyche, which is about 226 kilometers in diameter, has a density of 3,400–4,100 kilograms per cubic meter. And although earlier observations suggested that the asteroid consists almost entirely of iron and nickel, it now appears that those metals make up only 30%–60% of its volume, with the rest consisting of silicate rock and pore space.

The origin of Psyche, the details of its structure, and the specific kinds of rock it contains remain mysterious. Is Psyche indeed the core of an early planet that was stripped of its outer layers by impacts with other objects? If so, what did that planet look like, and what kinds of collisions and other conditions shaped its fate? Or did it form in some previously unimagined scenario?

The new findings help constrain the possible answers to these questions, providing valuable context for the upcoming mission to Psyche—the first mission to a metallic asteroid. Observing Psyche up close should provide final answers about the asteroid and could improve understanding of how Earth and other planets formed. (*Journal of Geophysical Research: Planets,* https://doi.org/10.1029/2019JE006296, 2020) **—Sarah Stanley,** *Science Writer*

While preparing for an upcoming NASA mission to observe the asteroid Psyche up close, scientists have uncovered new insights into the composition and origin of this enigmatic asteroid. Credit: ASU/P. Rubin/NASA

Improving Climate Predictions over Decades

Earth's climate system is chaotic and nonlinear. These characteristic impose limits on how well scientists can predict climate statistics related to temperature, precipitation, and other variables. (The degree to which skillful predictions can be made is called predictability.) The steady evolution of climate modeling over the past several decades has led to significant strides in seasonal climate prediction, but forecasting the climate over decades has proved more challenging.

At the timescale of decades, climate swings are driven by both internal dynamics, like the El Niño–Southern Oscillation, and external factors (e.g., volcanic eruptions). The limits and mechanisms of these phenomena are still not fully understood, which imposes boundaries on the climate's long-term predictability.

Zhang and Kirtman recently explored climate predictability over decades. The authors applied an interactive ensemble coupling strategy to the Community Climate System Model (CCSM4) to create climate simulations with decreased atmospheric noise at the air-sea interface. In other words, they reduced short-term variability in the climate model. By reducing this noise, the authors isolated the climate signal in the model and were able to quantify how the noise affects predictability. To measure predictability, they used the nonlinear local Lyapunov exponent (NLLE) method, which was the first use of NLLE with state-of-the-art coupled climate models.

The study determined that the interactive ensemble approach underestimates decadal predictability compared with estimates generated from observational data. However, the results indicated that predictability varies by region. Forecasts from the North Atlantic Ocean were more predictable, for instance, whereas the Indian and Southern oceans were less predictable than the control simulations.

The authors also evaluated the predictability of subsurface ocean temperature in the North Atlantic. In regions without external climate forcings, the interactive ensemble method resulted in decreased predictability. In areas with both internal and external dynamics, predictability increased. The mechanisms for these patterns, however, require further investigation.

Although the study does not solve the challenge of long-term predictability of climate models, the findings do suggest that decadal predictability is related to both internal climate variability and ocean dynamics. (*Geophysical Research Letters,* https://doi.org/10.1029/2018GL081307, 2019) **—Aaron Sidder,** *Science Writer*