High-resolution ocean model provides insight into sea turtles' lost years

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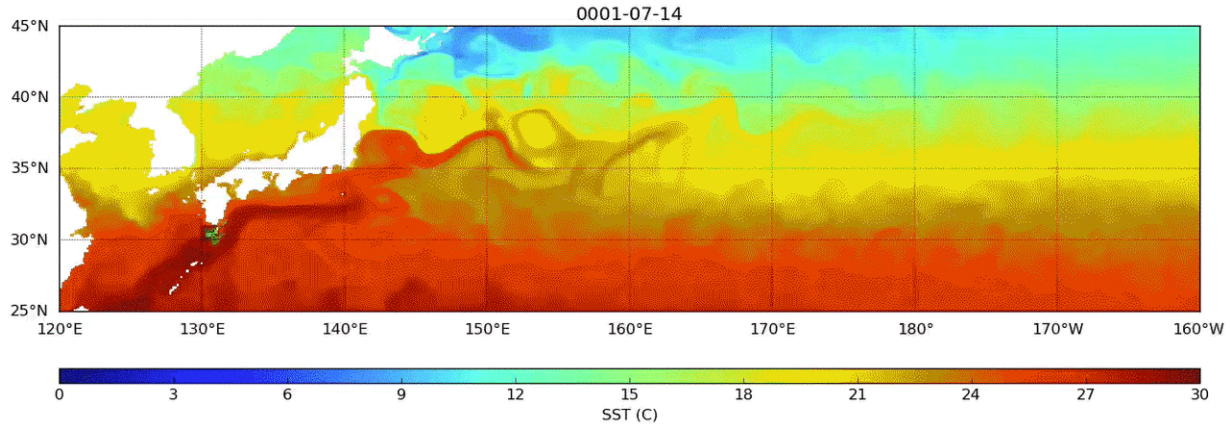

An animation depicting how baby sea turtles likely disperse from a nesting site in Japan into the open ocean. The "turtles" are green particles in this simulation, which was run using a high-resolution version of the NCAR-based Community Earth System Model. Credit: Cheryl Harrison

An exquisitely detailed global ocean model simulation from the National Center for Atmospheric Research (NCAR) has given scientists rare insight into where baby sea turtles may go in their "lost years" after they scramble off the sandy beaches where they are born and swim into the open ocean.

This look at a critically important period in the life cycle of endangered loggerhead turtles could help inform more comprehensive conservation

efforts that encompass regions of the open ocean where young turtles grow, and not just the nesting beaches. It also pinpoints regions of the ocean that are important to study to better understand how to protect sea turtles.

"To understand where sea turtle hatchlings are being swept to when they enter the open ocean—and how favorable that habitat is to turtle survival—we need to simulate smaller scale ocean features, the jets and eddies that transport these younglings," said Cheryl Harrison, a researcher at the University of Texas Rio Grande Valley, who led the study. "The models typically used to simulate global ocean movement are too coarse for us to resolve these important features. The really exciting thing about this study is we were able to use a high-resolution, eddy-resolving model to track where turtles are traveling."

The ocean simulation used for the new study, published in the *Journal of The Royal Society Interface*, was run using the NCAR-based Community Earth System Model at a resolution that is an order of magnitude higher than standard global modeling runs. The model also contains complex biogeochemistry, which allowed the researchers to estimate food availability along the turtles' path.

The research was funded by the National Science Foundation, which is NCAR's sponsor, NASA, and the U.S. Department of Energy. Harrison began work on the study as a postdoctoral researcher at NCAR, working with oceanographer Matthew Long, who co-authored the study. Harrison is now an assistant professor at the University of Texas Rio Grande Valley.

Finding the lost years

Loggerhead turtles nest on specific beaches scattered around the globe, often where strong currents come close to land. After hatching, the baby

turtles head for the ocean, where they spend the next several years as they mature. Once they reach sexual maturity decades later, the turtles eventually return to the beach where they were born to mate and lay their own eggs before the cycle begins again.

For the new study, Harrison and her colleagues studied how hatchlings are likely to disperse during the first year of their lives from nesting sites on the coasts of Japan, Florida, Cape Verde, Oman, west Australia, east Australia, Brazil, and South Africa. Because the baby sea turtles must stay near the surface of the ocean to breathe—and because they are not yet able to swim for significant periods—the researchers were able to emulate their possible journeys using a method known as particle tracking, which follows how particles "released" into the model move with simulated water trajectories over time.

The results show that at many of the nesting sites, strong nearby currents—including the Kuroshio, Gulf Stream, Brazil, and Agulhas currents—sweep the turtles poleward to a region of ocean where two circular ocean currents (known as gyres) come together. This boundary between the subpolar and subtropical gyres is warm enough for the hatchlings to survive and also rich with zooplankton and other food that turtles depend on to survive.

The study results help demarcate the regions where turtles from each beach are going in their "lost years" when ecologists cannot easily keep tabs on them. For example, turtles born in southeastern Florida travel with the Gulf Stream all the way to the Azores, a productive and warm ocean habitat perfect for nurturing them.

At other nesting sites, such as the one on the coast of Oman, the hatchlings do not hitch a ride on a strong current to far-off ocean habitats. Instead, they use a local current that disperses them relatively nearby because the area waters are already suitable for the young turtles.

This understanding of where the turtles go allows scientists to better understand what threats the turtles may be facing.

"Sea turtle hatchlings are very difficult to track and observe as they have high mortality rates and grow out of tags quickly," Harrison said. "Modelling studies help us close this observational gap and predict where they are going in the 'lost years.' Identifying ocean habitat helps us understand what factors are important for their survival in this life stage."

More information: Cheryl S. Harrison et al, Identifying global favourable habitat for early juvenile loggerhead sea turtles, *Journal of The Royal Society Interface* (2021). DOI: 10.1098/rsif.2020.0799

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