Researchers develop innovative approach to measure shallow water depth with satellite data

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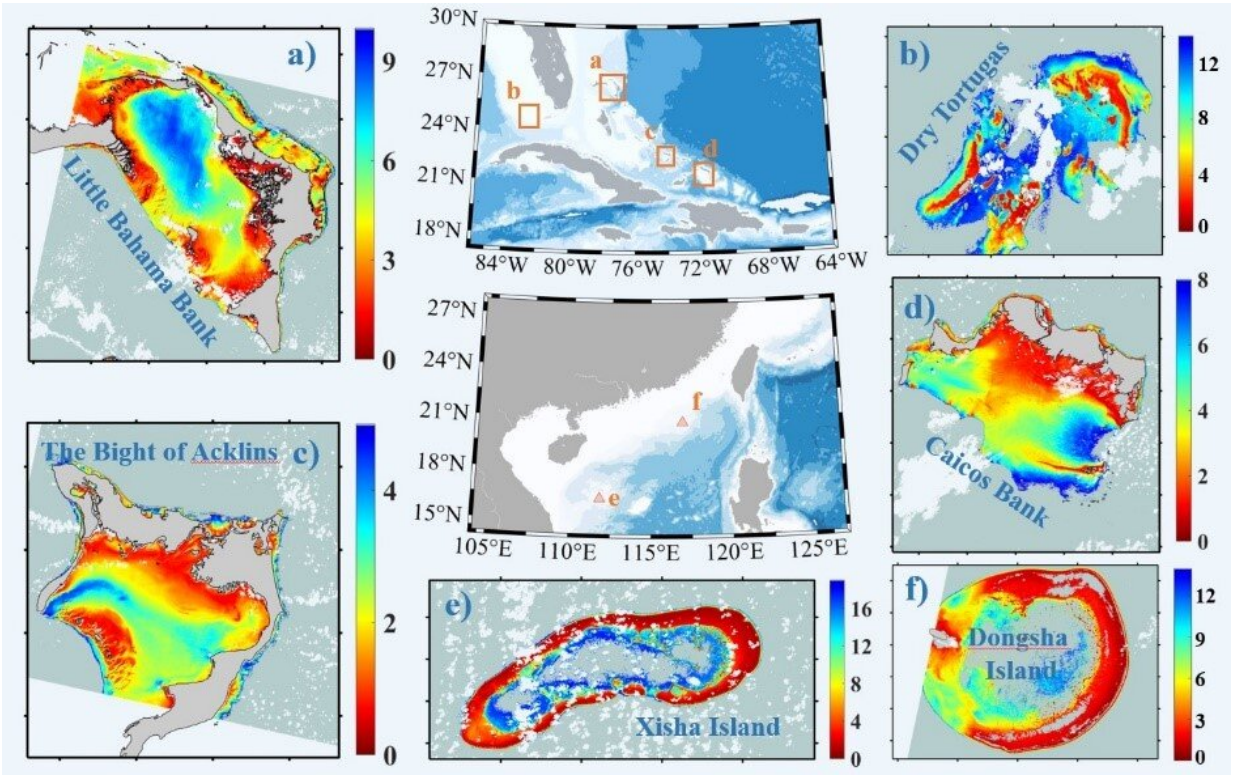

Scientists from Xiamen University, China obtained highly accurate, high-spatial resolution, shallow-water bathymetry from satellite measurements. Credit: Optical Oceanography Laboratory, Xiamen University

The top of the atmosphere is the agreed-upon border between Earth's

atmosphere and outer space. Satellites traverse this space, facilitating global communications and imaging the planet, measuring changing ice coverage heights and land mass shifts. While the satellite technology is incredibly advanced, it is a long-standing challenge to produce accurate depth of water for every shallow area off coastlines, according to researchers from Xiamen University and the University of Massachusetts Boston.

The issue is not the type or amount of data collected, the researchers said, but rather how to translate it into an accurate estimation of how shallow nearshore waters are. To solve this challenge, they developed a machine learning algorithm that uses data from two Earth observation satellites to determine the depth of optically shallow waters.

They published their approach on Feb. 3 in the *Journal of Remote Sensing*.

"Nearshore shallow water environments such as coral reefs, seagrass, and kelp beds are among the most socioeconomically important and productive ecosystems in the world; its monitoring is an important task of many government agencies," said Zhongping Lee, corresponding author and Emeritus Professor in the School for the Environment at the University of Massachusetts Boston. "In addition to monitoring changes across bottom substrates in such ecosystems, one desired parameter is the bottom depth, as it is important not only for navigation but also for studies of coastal processes and management of coastal events ranging from monitoring of storm surge to site selection of wind farms."

Bottom depth measurement, called bathymetry, was conventionally conducted via sonar, but as satellite technology improved, more and more measurements were taken via satellite lidar.

"While these methods and systems provide a high precision

measurement of bottom depth, they are high-cost, time-consuming and limited to the areas the vessels (for sonar) can reach or the lines satellite lidar draws, with the resulting data from space unable to form a high-resolution bathymetric map," said first author Wendian Lai, graduate student in Xiamen University's College of Ocean and Earth Sciences.

The researchers used publicly available data from the Operational Land Imager on Landsat 8, a U.S. Geological Survey and NASA satellite, and from the Advanced Topographic Laster Altimeter System (ATLAS) instrument on ICESat-2, a NASA satellite that measures various elevation points on the planet. ICESat-2 beams lasers at points of interest and times how long the laser takes to reach the point and return to the satellite. The ATLAS data contains the latitude, longitude and time for all photons—the constituents of the laser beams—downlinked by the satellite.

The team concentrated on data measurements from the Great Bahama Bank and the Cay Sal Bank, training an artificially intelligent neural network to understand how the co-located data points could, together, indicate depth.

"The algorithm accurately labeled optically shallow waters and optically deep waters 100% of the time," Lai said.

The researchers noted that, while the results are "promising," this study focused on tropical and subtropical regions, where water is generally clear. However, their approach can apply to other regions once the imaging data from Landsat 8 is collected.

"This system demonstrates a strong portability that is lacking in conventional algorithms," Lee said. "We plan to apply this system to many regions, with the goal of generating global high-resolution bathymetric maps of near-shore shallow regions."

More information: Wendian Lai et al, A Portable Algorithm to Retrieve Bottom Depth of Optically Shallow Waters from Top-Of-Atmosphere Measurements, *Journal of Remote Sensing* (2022). DOI: 10.34133/2022/9831947

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