Mapping sea salt from orbit: Building better ocean and climate models with salinity data

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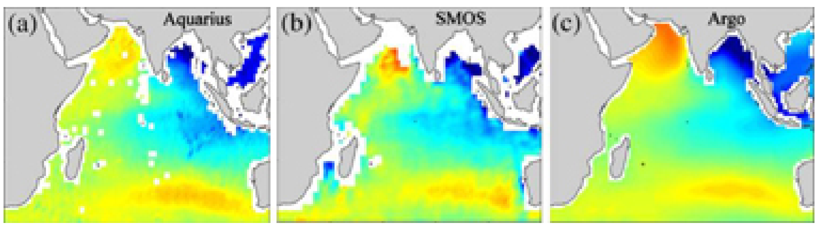

New satellite data being analyzed at the University of South Carolina are giving scientists a highly detailed map of surface ocean salinity, a critical need for improving ocean and climate models. Credit: Remote Sensing of the Environment

(Phys.org) —Once a valuable commodity, salt is now more often a focus of scorn for unhealthy dietary overuse. A new respect is at hand, though – at least among scientists. New satellite data about the flow of salt through the world's oceans is providing the basis for more precise global ocean and climate models.

Contrary to common perception, salinity is hardly uniform in the world's oceans. "It's apparent when you look at a surface salinity map of the Indian Ocean," said Subrahmanyam Bulusu, the director of the Satellite Oceanography Laboratory in the College of Arts and Sciences at the University of South Carolina. "In the northern part of the Arabian Sea, the salinity is considerably higher than in the northern part of the Bay of Bengal."

The surface salinity differences are driven by a combination of ocean currents, precipitation, evaporation and river runoff. The water cycle is central to global climate models, and salt strongly affects ocean currents because the saltier water is, the denser – and thus more slow-moving – it is.

"Salinity is often neglected in climate studies, yet it plays a critical role," said Bulusu, USC's campus director of the NASA/South Carolina Space Grant Consortium.

Climate scientists recognize that the atmosphere is greatly influenced by the flow of heat energy carried by ocean currents. But precisely quantifying the mixing between the ocean and the atmosphere is hampered by a lack of detail in models of the ocean and of the water cycle.

And in both models, the salt content of the water is essential.

"Most of the global ocean and coupled ocean-climate models use salinity from climatological data," said Bulusu. "But the observed data over the past 50 years are very sparse, because they're only from shipping lanes or moored buoys in one location."

That's now changing with the arrival of the European Space Agency's (ESA's) Soil Moisture and Ocean Salinity (SMOS) mission and NASA's Aquarius mission, launched in November 2009 and June 2011, respectively. Each is equipped to measure sea surface salinity over the entire globe.

The level of detail provided by the satellites is far beyond anything collected from the ocean's surface. "A major goal of these satellite missions is to better define the water cycle," said Bulusu. "The spatial and temporal coverage will be much better, which will definitely help global ocean and climate models. With recent research findings suggesting that salty regions are getting saltier and fresh regions are getting fresher, these satellites couldn't have arrived at a better time."

In January, Bulusu's laboratory reported the first SMOS measurements taken over the Indian Ocean. Published in IEEE Transactions on Geoscience and Remote Sensing (link here), the study is helping to bridge the gap between data derived from ocean-based floats (such as the Argo network of some 3,500 robotic probes deployed worldwide, of which about 800 are in the Indian Ocean) and measurements from the orbiting satellite. But with a goal of measuring differences of just 0.1 practical salinity units (psu), Bulusu's team found some challenges in validating the SMOS satellite data.

Radio frequency interference, for example, hampered measurements in the northern Indian Ocean. The satellite's onboard radiometer measures frequencies in a microwave range (1400-1427 MHz) that by international agreement is reserved for scientific studies. Nonetheless, interference near coastlines proved to be a significant problem.

Moreover, salinity data within 150 km of the coast remain problematic with both instruments. SMOS is designed to collect data over land (soil moisture) and sea (ocean salinity), but the instrument is unable to switch immediately between the two surfaces. "We also need to develop better algorithms for Aquarius near coastal areas," Bulusu said. "That's something we're actively working on right now."

Bulusu's team at USC also just published the first long-term study of salt movement in the Indian Ocean, covering 1960 through 2008, in Remote Sensing of the Environment (link here). Using a Simple Ocean Data Assimilation (SODA) reanalysis, they were able to compare the output with the sparse data available over the nearly 50-year period and with Aquarius salinity data.

What they've found is that the area is a perfect site for validating the new satellites.

"The Indian Ocean has strong winds and currents, and they're also highly variable. On the other hand, the Bay of Bengal has low-saline waters and the Arabian Sea is saltier, even though both are at same latitude" Bulusu said. "That makes it ideal for calibrating both the SMOS and the Aquarius satellite data."

Given the limitations with the ESA's SMOS mission measurements and the preliminary work that they've completed with NASA's Aquarius satellite mission, Bulusu and his team are enthusiastic about the latter's arrival onto the scene.

"The Aquarius satellite has some real advantages, particularly in accuracy and sampling," Bulusu said. "With this long-term study, we now have a solid framework for developing a very detailed map of salt movement in the Indian Ocean. We can use that to prepare a global map that should be very useful in improving climate and forecasting models."

Provided by University of South Carolina

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