Scripps Researchers Unraveling Enigma of ‘Flash’ Rip Currents

AGU Fall Meeting presentations describe new methods devised to decode key beach processes that pose hazards to swimmers

Scripps Institution of Oceanography/University of California, San Diego

Rip currents are the narrow and unpredictably dynamic bursts of water that jet out from the beach shore to deeper waters. Because they play a fundamental role in beach processes around the world, from transferring key biological matter and pollutants to mixing heat in the surf—in addition to posing a potential hazard to novice beach swimmers each summer—coastal oceanographers want to know more about them.

While more is understood about rip currents that are linked with the shape of the seafloor, Scripps coastal oceanographers are setting their sights on a second, much more unpredictable type of the phenomenon known as transient, or “flash” rip currents.

An aerial image of pink dye measurements taken during a field project in Imperial Beach, Calif, highlights two prominent rip currents.
Building upon years of field data from beach experiments at various locations, researchers at Scripps Institution of Oceanography at UC San Diego are now employing state-of-the-art modeling and computing techniques to untangle the mysteries of flash rip current processes and help reveal what makes them tick—including how they evolve and dissipate.

Two presentations at the 2014 American Geophysical Union (AGU) Fall Meeting will describe these new simulations *(OS11A-1253 • Sutara Suanda: Quantifying Transient Rip Current-driven Exchange between the Surf Zone and Inner Shelf • Monday, Dec. 15, 8 a.m. – 12:20 p.m. • Moscone West Poster Hall; and OS11A-1255 • Nirnimesh Kumar: Modeling Surf Zone-Inner Shelf Exchange: Interaction of Rip Currents and Stratification • Monday, Dec. 15, 8 a.m. – 12:20 p.m. • Moscone West Poster Hall).*

“Transient rip currents are a process of turbulence, which is hard to predict in general,” said Falk Feddersen, an acting professor of physical oceanography at Scripps and lead investigator in the rip current simulation projects. “They’re not necessarily like tornadoes, but some of the challenges in predicting them—due to the complexity and nonlinearity involved—are similar.”

Scripps postdoctoral researcher Sutara Suanda will describe new simulations, supported by the National Science Foundation, that merge a range of beach conditions, including the slope of the beach, wave steepness, wave height, and the directional spread of incoming waves, to track how rip currents evolve from the beach to the deeper offshore area known as the “inner shelf.” Computer models that incorporate realistic nearshore physics have only become available within the past 10 years and now allow Suanda to vary beach parameters to formulate a range of possible rip current origins and evolutions.

Early results characterize flash rip currents as much more powerful than previously believed.

“This new transient-rip-current-driven exchange process is far stronger than the classical way that we have been thinking about exchange between the surf zone and the inner shelf,” said Suanda.
“This is a paradigm shift in how we think pollution, larvae, and nutrients are exchanged in the surf zone,” said Feddersen.

A separate project led by Scripps postdoctoral researcher Nirmimesh Kumar and funded by the Office of Naval Research builds upon Suanda’s simulations by investigating rip currents as they progress further offshore. Since ocean waters are divided into temperature layers with warmer water near the surface and colder water below, Kumar is studying how such layers influence rip current dynamics from the beach to deeper waters by inhibiting or enhancing the strength of the rip current.

Four snapshots depict the evolution of a flash rip current, which originates with small patches of vorticity (a and b panels) that come together into a coherent structure (c panel).
“We can study the impact of stratification on rip currents, and nearshore exchange, by varying the influence of stratification,” said Kumar.

Such an intricate task of uniting state-of-the-art computing models is important to understand how the coastal zone functions, said Feddersen, because rip currents are also known to act as a mixing tool, churning water back to the surf zone.

“Transient rip currents can take stratified water and bring it into the surf zone, mix it, and then spit it out again—not only pollutants but heat as well,” said Feddersen.

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