Study explains Pacific equatorial cold water region

July 25 2013

Researchers from Oregon State University working in the equatorial Pacific Ocean are learning more about mixing of ocean waters. Credit: Oregon State University

A new study published this week in the journal *Nature* reveals for the first time how the mixing of cold, deep waters from below can change sea surface temperatures on seasonal and longer timescales.

Because this occurs in a huge region of the ocean that takes up heat from the atmosphere, these changes can influence global climate patterns, particularly global warming.

Using a new measurement of mixing, Jim Moum and Jonathan Nash of the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University have obtained the first multi-year records of mixing that permit assessment of seasonal changes. This is a significant advance beyond traditional shipboard measurements that are limited to the time that a ship can be away from port. Small instruments fueled by lithium batteries were built to be easily deployed on deep-sea equatorial moorings.

Moum employs a simple demonstration to show how mixing works.

He pours cold, white cream into a clear glass mug full of hot, black coffee, very carefully, using a straw to inject the heavier cream at the bottom of the mug, where it remains.

"Now we can wait until the cream diffuses into the coffee, and we'll have a nice cuppa joe," Moum says. "Unfortunately, the coffee will be cold by then. Or, we can introduce some external energy into the system, and mix it."

A stirring spoon reveals motions in the mug outlined by the black/white contrasts of cream in coffee until the contrast completely disappears, and the color achieves that of café au lait.

"Mixing is obviously important in our normal lives, from the kitchen to the dispersal of pollutants in the atmosphere, reducing them to levels that are barely tolerable," he said.

The new study shows how mixing, at the same small scales that appear in your morning coffee, is critical to the ocean. It outlines the processes that create the equatorial Pacific cold tongue, a broad expanse of ocean near the equator that is roughly the size of the continental United States, with sea surface temperatures substantially cooler than surrounding areas.

Because this is a huge expanse that takes up heat from the atmosphere, understanding how it does so is critical to seasonal weather patterns, El Nino, and to global climate change.

In temperate latitudes, the atmosphere heats the ocean in summer and cools it in winter. This causes a clear seasonal cycle in sea surface temperature, at least in the middle of the ocean. At low latitudes near the equator, the atmosphere heats the sea surface throughout the year. Yet a strong seasonal cycle in sea surface temperature is present here, as well. This has puzzled oceanographers for decades who have suspected mixing may be the cause but have not been able to prove this.

Moum, Nash and their colleagues began their effort in 2005 to document mixing at various depths on an annual basis, which previously had been a near-impossible task.

"This is a very important area scientifically, but it's also quite remote," Moum said. "From a ship it's impossible to get the kinds of record lengths needed to resolve seasonal cycles, let alone processes with longer-term cycles like El Nino and La Nina. But for the first time in 2005, we were able to deploy instrumentation to measure mixing on a NOAA mooring and monitor the processes on a year-round basis."

The researchers found clear evidence that mixing alone cools the sea surface in the cold tongue, and that the magnitude of mixing is influenced by equatorial currents that flow from east to west at the surface, and from west to east in deeper waters 100 meters beneath the surface.

"There is a hint – although it is too early to tell – that increased mixing may lead, or have a correlation to the development of La Niña," Moum said. "Conversely, less mixing may be associated with El Niño. But we only have a six-year record – we'll need 25 years or more to reach any conclusions on this question."

Nash said the biggest uncertainty in climate change models is understanding some of the basic processes for the mixing of deep-ocean and surface waters and the impacts on sea surface temperatures. This work should make climate models more accurate in the future.

More information: *Nature* (24 July 2013) doi:10.1038/nature12363

Provided by Oregon State University