Currents of the Western South Pacific

The low-latitude western boundary currents (LLWBCs) of the Pacific have been shown to play a very important role in the development of El Niño. They are also a key component of the global thermohaline circulation. These currents are therefore believed to be important in determining the world's climate. In the Northern Hemisphere, the LLWBCs include the Mindanoa Current and the Luzon Undercurrent; in the Southern Hemisphere, the New Queensland Current and the New Guinea Coastal Undercurrent.

A fair amount is known about the Northern Hemisphere LLWBCs, but much less is known about their Southern Hemisphere counterpart. The South Equatorial Current, as it approaches the Australian coast, splits into the southward-flowing East Australian Current and the northward-flowing North Queensland Current. The precise location of this bifurcation determines the amount of subtropical water imported to the tropics via the LLWBCs, and hence is probably significant for Pacific climate variability. The large-scale circulation of the western South Pacific has been broadly described based on various synoptic observations, and there is evidence to suggest the existence of a subsurface countercurrent, i.e., the Great Barrier Reef Undercurrent flowing northward underneath the East Australian Current at about 18°S. The detailed structure of the South Equatorial Current bifurcation, however, has never been carefully examined due to sporadic sampling.

Tangdong Qu, associate researcher at the IPRC, and his collaborator **Eric Lindstrom**, Oceanography Program Scientist at NASA, recently constructed a new data set using all existing hydrographic observations and provided a climatological interpretation of the circulation in the western South Pacific. By averaging the data along isopycnal surfaces in a 0.5°x0.5° grid, with an e-folding smoothing scale of about 100 km, they show many detailed phenomena associated with the narrow western boundary currents along the coast of Australia and Papua New Guinea.

Panels (a) and (b) of Figure 2 show the dynamically calculated (relative to 1200 db) velocity fields at 300 and 800 m, and panel (c) shows the alongshore component of the flow averaged within a 2°-longitude band from the coast. Over a large part of the region studied, say, south of 15°S, the signature of the South Equatorial Current is weak at the sea surface, and the surface flow seems to be predominantly eastward (not shown). At about 300 m (Figure 1a), the current is fully developed, and at deeper levels, it becomes weaker but more widely spread (Figure 1b).

This study reveals two significant features. First, with increasing depth, the bifurcation of the South Equatorial Current shifts southward, from about 15°S near the surface to about 22°S in the intermediate layers (Figure 2c). As a result, the origin of the Great Barrier Reef Undercurrent is at about 22°S, which is somewhat farther south than previously thought. Further north, the Great Barrier Reef Undercurrent intensifies below the East Australian Current and merges with the North Queensland Current at about 15°S, adding to the waters that flow into the New Guinea Coastal Undercurrent through the Louisiade Archipelago. Second, a strong water-property connection exists between the Coral and Solomon Seas. Water of South Pacific origin, such as the South Pacific Tropical Water and the Antarctic Intermediate Water, can be traced from the Great Barrier Reef Undercurrent and the North Queensland Current to the New Guinea Coastal Undercurrent, supporting the hypothesis that the New Guinea Coastal Undercurrent comes from the south via the Coral and Solomon Seas.

This identification of the structure of these Southern Hemisphere LLWBCs provides a background for understanding the circulation, including the thermohaline circulation, in the western South Pacific, as well as a guideline for the design and analysis of future observations and simulations of the region. The findings, thus, are a significant step toward understanding the role of ocean circulation in global climate and climate change.

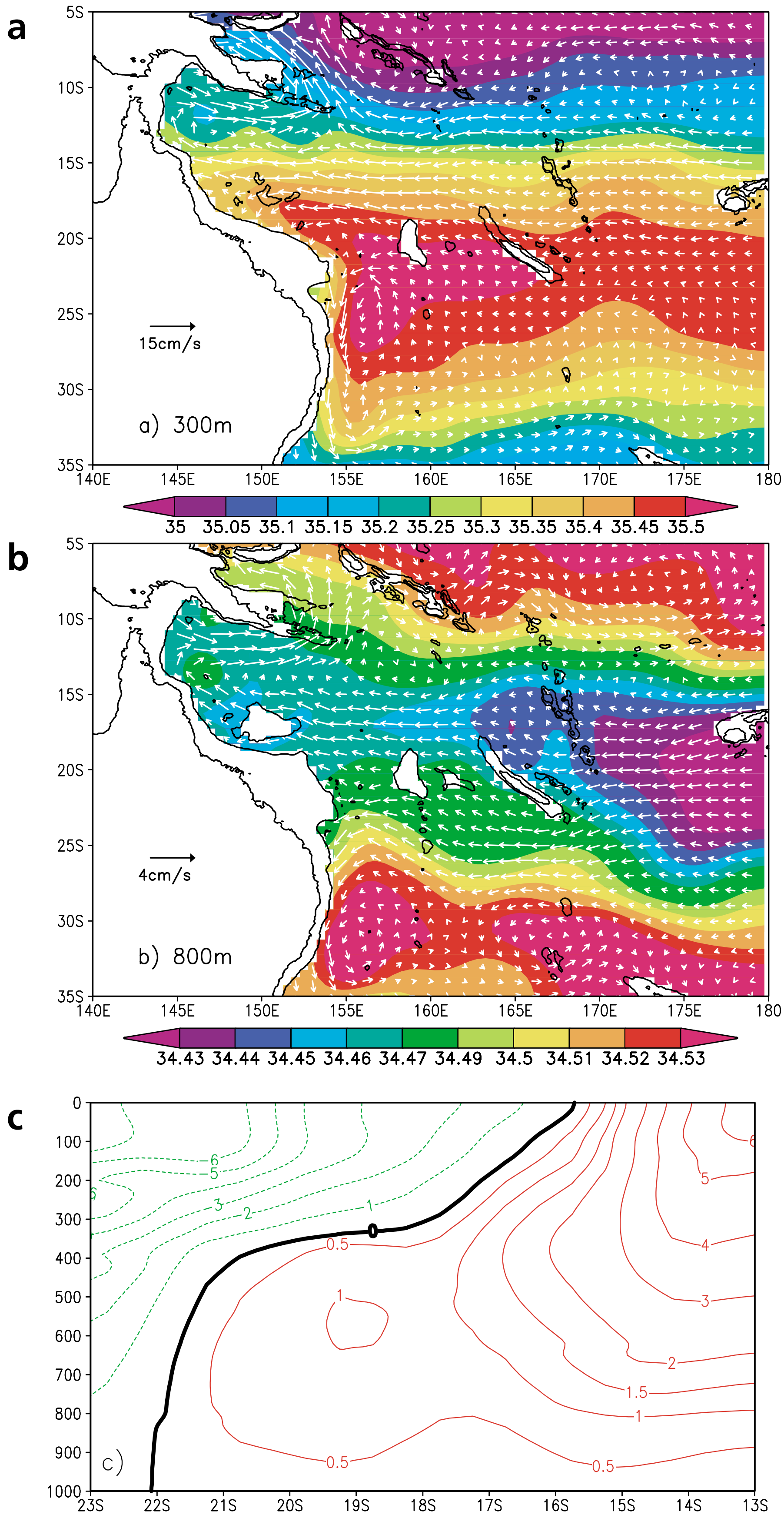

Figure 2. *Geostrophic velocity (relative to 1200 db) and salinity fields at (a) 300 m and (b) 800 m in the western South Pacific, and (c) the alongshore component of the flow (cm^{-1}) averaged within a 2°-longitude band from the coast. Positive values in (c) are northwestward, and the contour of zero velocity indicates the bifurcation of the SEC.*