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Observational and model studies on relationship between coastal upwelling in the Bismarck Sea and El Nino events

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We investigate variations of oceanic thermal condition, upper-ocean currents, and surface winds in the western equatorial Pacific, especially in the Bismarck Sea east of New Guinea, using observational data and high-resolution OGCM (OFES) hindcasts, and long-term simulation of high-resolution air-sea coupled global model (SINTEX-F2).

During December 2001-January 2002, coastal upwelling occurred along the Papua New Guinea (PNG) coast, and then upwelled relatively cool water spread out over a wider area to the northeast. Simultaneously, strong northwesterly surface winds occurred along the north coast. At that time, a northeastward outflow toward the equator from the PNG coastal area is also found. This northeastward outflow could bring the upwelled relatively cool coastal water, to the western equatorial South Pacific near PNG. The present results indicate that northeastward transport of the cold water is related to the complicated upper-ocean currents in the Bismarck Sea, and that would strongly affect the upper-ocean thermal change in the western equatorial Pacific near PNG in association of coastal upwelling before the onset of 2002/2003 El Nino event.

It is also shown that the relatively cold water related to the coastal upwelling generates positive zonal gradient of SST in the western equatorial Pacific. At that time, intraseasonal strong surface westerly winds occur in this region. Such relationship between strong surface westerly winds and positive SST gradient in the western equatorial Pacific is consistent with those expected from previous theoretical and model studies.

Furthermore, similar SST patterns to the observed SST pattern during PNG coastal upwelling are also found in 200-year simulation of high-resolution air-sea coupled general circulation model (SINTEX-F ver2). Roughly a half of such SST cooling events appear prior to the El Nino events. The present study suggests that the small-scale phenomenon related to PNG coastal upwelling can contribute to onset of El Nino events via oceanic and atmospheric changes in the western equatorial Pacific.

Keywords: coastal upwelling, El Nino event, tropical western Pacific, airi-sea interaction, intraseasona-to-interannual scale