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Special Section:
Western Pacific Ocean Circulation and Climate

Introduction to special section on Western Pacific Ocean Circulation and Climate

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The western Pacific Ocean (WPO) is a cross road and a major pathway whereby different water masses converge or traverse from mid-latitude and high-latitude to adjacent oceans and ambient marginal seas. One protruding feature of the WPO is the warm pool, the world's warmest open ocean surface water spanning the northern and southern tropical WPO. The warm pool modulates global and regional climate systems, including the El Niño-Southern Oscillation (ENSO) and the Asian and Australian monsoon. The other feature is the Western Boundary Current (WBC) system, which consists of the Kuroshio and the East Australian Current, and, uniquely, two equatorward low-latitude WBCs, the Mindanao Current in the North Pacific, and Gulf of Papua Current/New Guinea Coastal Current system in the South. These two features are closely linked; a recharge or discharge of the warm pool triggers a response of the WBCs, and variability of the WBCs in turn modulates the evolution of the warm pool.

This special section on *Western Pacific Ocean Circulation and Climate* of the Journal of Geophysical Research assembles 31 research papers, mainly presented at the *Open Science Symposium on Western Pacific Ocean Circulation and Climate* held on 15–17 October 2012 in Qingdao, China, under the auspices of the Northwestern Pacific Ocean Circulation and Climate Experiment (NPOCE) [*Hu et al.*, 2011] and Southwest Pacific Ocean Circulation and Climate Experiment (SPICE) [*Ganachaud et al.*, 2007]. The goal of this inaugural symposium was to provide a forum for scientists to exchange the latest knowledge pertaining to the WPO circulation and climate. The presentations consisted of 6 keynote talks, 11 invited talks, 40 contributed talks, and 73 poster presentations, covering a wide range of important areas, including dynamics and variability of the WBCs, their interaction with the ambient circulation, roles of the WPO circulation in variability of the warm pool and ENSO, in regional climatic systems (e.g., monsoon, typhoon, and extreme climatic events) and their predictability, and in carbon cycle, biogeochemical process, acidification, ecosystem, and paleooceanography.

Included in this special section are 31 research articles documenting the latest progress in our understanding of the WPO, including the Pacific basin-scale circulation, the Indonesian throughflow (ITF), Asian monsoon, and climate change in the Pacific Ocean. A considerable body of the results is based on in-situ data, remote sensing, and numerical models, which contribute to the NPOCE, SPICE, and ITF studies. As such, the results presented in this special section attest to the effectiveness and success of these international programs. Some highlights are presented below, as a taster.

In the northwest Pacific, significant progress has been made toward understanding the WBC and this includes a depiction, based mainly on in situ current measurements, of the Mindanao Undercurrent, the Luzon Undercurrent, and their connection with the North Equatorial Undercurrent. The latest result verifies the existence of the Mindanao Undercurrent, which features a core centered at around 900 m, some 300 m deeper than previously estimated using geostrophic balance. The strong intraseasonal variability and intense interactions of the Mindanao Undercurrent with the Luzon Undercurrent and the North Equatorial Undercurrent were also previously poorly appreciated. Another advance lies in our improved understanding of decadal variability of the North Equatorial Current bifurcation, which shows a southward shift of its latitude after the 1998/1999 La Niña event, contributing to the North Pacific regime shift.

In the South Pacific, knowledge of the Southwest Pacific circulation, including ocean circulations of the Coral, Solomon, and Tasman seas, has been substantially improved. These include a new depiction of two

South Equatorial Current branches that enter the Coral Sea between New Caledonia and the Solomon Islands, form jets, feed the Gulf of Papua Current against Australia, and flow into the Solomon Sea in the New Guinea Coastal Current system. During this long transit, waters are found to be enriched through land-ocean boundary exchanges, inducing downstream consequences such as iron fertilization. Another highlight is that showed from the recent mooring measurements, the East Australian Current feeding filaments such as the Tasman Front is weaker than previously thought.

In the ITF research area, a reconstructed 18-year transport time series shows that the partitioning of the total ITF transport through each of the major outflow passages (Lombok, Ombai, and Timor) varies according to the phase of the Indian Ocean Dipole and ENSO. Further, in situ observations show coherent intraseasonal (30–70 days) variations, with the eastern equatorial Indian Ocean leading the Lombok and Ombai Straits.

Analyses of basin-scale processes produce many interesting results, including an anticorrelation of the WBC with the Subtropical Cells, and coherent variations of meridional transports at 32°S with the Southern Annular Mode. On smaller scales, the Halmahera and Mindanao Eddies and eddies in the Solomon Sea were investigated in terms of their generation, structure, and propagation using observations, high-resolution numerical simulations, and altimetric data. In particular, eddies in the Solomon Sea show a strong seasonal and interannual modulation with maximum activities in June and/or during La Niña events.

In addition to observation-based analyses, coupled ocean-atmosphere models were deployed to elucidate important processes, particularly those for which sufficient data are still not available, such as salinity evolution, vertical distribution of wind energy, and impact of the warm pool and ENSO on Asian monsoons. One highlight is that in the Solomon Sea, WBC advection, upwelling, and river discharge emerge as identifiable processes that even in a small region could affect salinity on seasonal time scales. Another is that in the Kuroshio region, wind-induced energy on near-inertial time scales could penetrate down to $\sim$3000 m and contribute to deep-ocean mixing. Further, the conclusion that heat content of the warm pool is a predictor of the South China Sea summer monsoon is reaffirmed, even on decadal time scales; likewise, the relationship between ENSO and the East Asian Winter Monsoon is confirmed to fluctuate substantially on decadal time scales.

Finally, comprehensive coupled ocean-atmosphere models were also deployed to provide a window to future WBC changes. For example, during the twentieth century, Antarctic ozone depletion and increasing greenhouse gases conspired to generate a conspicuous poleward intensification of the mid-latitude positive wind stress curl and hence the Southern Hemisphere oceanic supergyre. The Antarctic ozone is projected to recover by 2045, which, by and large, offsets the effect of increasing greenhouse gases before 2045, but thereafter the poleward intensification is modeled to resume and accelerate. This intensification implies a southward influence of warm subtropical East Australian Current waters into the western Tasman Sea, where warming has been observed to proceed at a rate about four times of the global average.

In summary, articles to this special section provide an overview of the latest science in the western Pacific ocean circulation and climate, identify research issues to be targeted, and raise questions to be resolved, in future endeavor through observations, process studies, and modeling. The guest editors thank all authors for their timely contribution. Especially, we are obliged to the AGU publication staff, editors, and reviewers for their unremitting work for this special section.

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