Tropical-subtropical exchange: contrasting mean & variability

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Introduction

Warm surface waters exported out of the tropics via Ekman flow are replenished by colder waters of extratropical origins in the pycnocline. Such an exchange affects tropical upper-ocean heat content and thus the climate. Previous studies primarily addressed time-mean exchange. In this study, TOPEX/Poseidon data & an assimilation product are used to examine the variability of exchange. Specifically, interannual variability of pycnocline transports via low-latitude western boundary currents (LLWBCs) & through the interior are contrasted with their mean values. The analysis focuses on latitudes critical to exchange in the Pacific (10N & 10S), Indian (8.5S), and the Atlantic (7S) Oceans (Fig.1). The assimilation product is available via http://www-ecco-group.org.

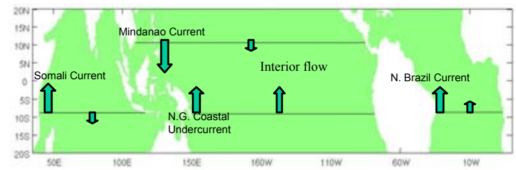

Figure 1 Schematic diagram of mean pycnocline flow involved in tropical-subtropical exchange.

Mean / Std. Dev.	Pacific 10N	Pacific 10S	Indian 8.5S	Atlantic 7S
Western boundary	-15.4 / 3.9	9.8 / 3.3	11.0 / 1.2	13.0 / 0.4
Interior	-4.5 / 4.6	9.8 / 4.0	-4.5 / 1.3	0.4 / 0.4

Table 1 Mean and standard deviation of pycnocline transports (in Sv). Pycnocline is as the layer between potential density surfaces of 22.5-26.7 and below 50 m. Positive: northward.

Time Mean

Consistent with previous studies, time-mean pycnocline transport via LLWBC estimated by the assimilation is substantially larger than that via the interior (Table 1); mean interior flow is generally in the same direction of the boundary flow.

Variability

Anomalies of zonal sea level slope across LLWBCs and the interior are generally anti-correlated with each other both for the T/P data and for the assimilation (Fig.2), suggesting that the two have the same feature in geostrophic flow near the top of the pycnocline. The assimilation propagates the constraint by T/P data into the pycnocline.

Indeed, anomalies of pycnocline transports inferred from the assimilation show that **(1)** boundary and interior pycnocline flows are anti-correlated and **(2)** the latter has a somewhat larger variability (Table 1).

<u>Mechanisms</u>

Lee and Fukumori (2003) provided a dynamical explanation of **(1)** and **(2)** in the Pacific for interannual-to-decadal time scales: a combined effect of near-equatorial wind on shallow meridional circulation and off-equatorial wind stress curl on horizontal circulation. Whether similar processes are at work in the Indian and Atlantic Oceans need to be investigated.

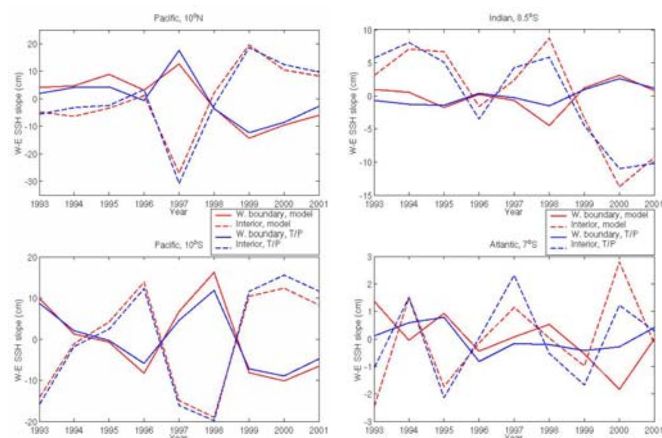

Figure 2 Anomalies of west-east sea level difference across the western boundary and interior tend to be anti-correlated to each other.

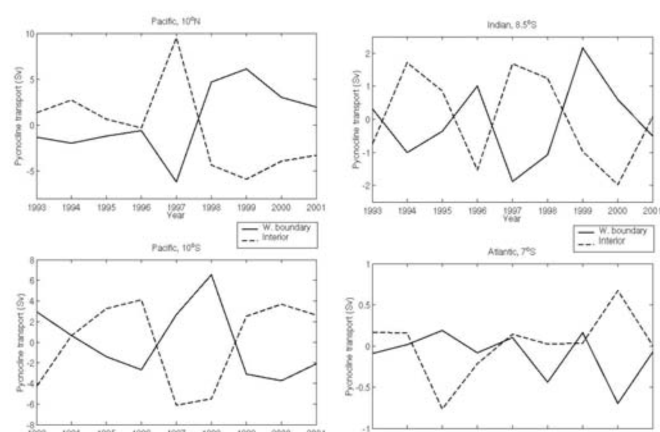

Fig. 3 Consistent with sea level slope (Fig.2), anomalies of pycnocline transports through western boundary and interior tend to be anti-correlated to each other.

Conclusion

Mean: boundary & interior transports generally in same direction; boundary transport > interior transport

Variability: boundary & interior transport generally out of phase; boundary transport < interior transport

Boundary pathway more important to time-mean exchange; interior pathway more important to variability of exchange.

Reference

Lee, T., I. Fukumori, 2003: Interannual-to-decadal variations of tropical-subtropical exchange in the Pacific Ocean: boundary vs. interior pycnocline transports. *J. Climate*, Vol. 16, No. 26, 4022-4042.