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Strong atmospheric surface pressure anomalies drive a see-saw in Subantarctic Mode Water formation

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The dominant Subantarctic Mode Water (SAMW) formation regions are located in the Indian, and in the Pacific sector of the Southern Ocean. Strong wintertime (Jul-Sep) surface air pressure anomalies with variance maxima at approximately 100°E and 150°W drive a zonal dipole structure in the SAMW formation and thickness, in both the Indian and Pacific sector of the Southern Ocean. This has been documented within gridded Argo data for years 2005-2019. A much weaker surface air pressure anomaly variance maxima is located in the Atlantic Ocean centered at approximately 25°W.

Anomalously strong positive pressure anomalies result in deepening of the wintertime mixed layers and an increase in the SAMW formation in the eastern part of the Pacific and Indian sector; these effects are due to cold southerly winds, strengthened zonal winds and increased surface ocean heat loss.

Anomalously strong negative pressure anomalies result in shoaling of the wintertime mixed layers and a decrease in SAMW formation in these regions, while at the same time deepening the wintertime mixed layers and increasing SAMW formation in the western Indian Ocean and in the central Pacific.

In years with strong El Nino, the interannual variability of the strength of two surface air pressure anomalies does not co-vary in phase with each other. Strong isopycnal heave in SAMW density range emanates from locations where winter surface air pressure anomalies and mixed layers are most strongly coupled.

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