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How is the mean seasonal cycle of SST determined by ocean dynamics off Java and Sumatra?

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An important question about the mechanisms of sea surface temperature (SST) variation off Java and Sumatra arises in a quick look at satellite observed SST and ocean color. Although ocean color indicates a distinctive upwelling season from July to September, the regional SST depression is rather small in comparison with other eastern boundary regions. Using historical hydrographic and recent Argo-float profile data, combined with results from a high-resolution ocean general circulation model, this study identifies the impact of ocean dynamics on the mean seasonal cycle of SST in the Southeastern Tropical Indian Ocean (STIO). Analysis of data shows that both the isothermal and mixed layers are deep (>60 m) in the equatorial STIO, but they do not have the same topographic structure. The mixed layer (ML) is more orientated along the coastline due to the effect of precipitation and runoff. This forms a thick barrier layer (>25 m) to the west of Sumatra. The thickness decreases to 10 m near eastern Java and less further to the east and south. The seasonal variation of barrier layer along the equator and off Sumatra/Java is a consequence of interplay between annual and semiannual variations. Further analysis of model results indicates that there are three dynamically different regimes within the region. First, near the coast of Northwest Australia, surface heat flux controls the seasonal variation of SST, while horizontal advection and vertical entrainment are relatively weak. This result is consistent with previous studies. Second, south of Java and farther to the east, warm horizontal advection of the Indonesian throughflow (ITF) neutralizes the cold upwelling. The transport of the ITF, especially the outflow from the Lombok Strait, reaches its seasonal maximum in July-September, at the same time that the maximum upwelling occurs. Third, west of Sumatra, the thick barrier layer impedes the cold thermocline water from entering the ML. Although upwelling occurs, it has no significant effect on the SST as a result of small vertical temperature gradient at the bottom of the ML.