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# New insights into concurrent air-sea heat flux forcing of Subantarctic Mode Water formation from mooring observations in the Southeast Indian and Southeast Pacific sectors of the Southern Ocean

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Wintertime surface ocean heat loss is the key driver of Subantarctic Mode Water (SAMW) formation. However, until now there have been very few direct observations of fluxes, particularly during winter. Here, we present results from the first concurrent (2015-17 with gaps), air-sea flux mooring deployments in two key SAMW formation regions: the Southern Ocean Flux Site (SOFS) in the Southeast Indian sector and the Ocean Observatories Initiative (OOI) mooring in the Southeast Pacific sector. Gridded Argo and ERA5 reanalysis provide temporal and spatial context for the mooring observations. Turbulent ocean heat loss is found to be on average 1.5 times larger at the Southeast Indian than Southeast Pacific sites with stronger extreme heat flux events in the Southeast Indian leading to larger cumulative winter heat loss. For the first time, we show that turbulent heat loss events in the Southeast Indian sector occur in two atmospheric regimes (a direct cold air pathway from the south and an indirect pathway circulating dry Antarctic air via the north). In contrast, heat loss events in the Southeast Pacific sector occur in a single atmospheric regime (cold air from the south). On interannual timescales, wintertime anomalies in net heat flux and mixed layer depth (MLD) are often correlated at the two sites, particularly when wintertime MLDs are anomalously deep. Using ERA5, we show that this is part of a larger zonal dipole in heat flux and MLD anomalies present in both the Indian and Pacific SAMW formation regions, associated with anomalous meridional atmospheric circulation. These recent results will be placed in the context of multidecadal variability in the SAMW formation region dominant heat flux patterns over the past 40 years over all 3 sectors of the Southern Ocean (Pacific, Indian and Atlantic).

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