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Observed mesoscale eddy sea surface temperature imprints

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A robust observational estimate of mesoscale eddy sea surface temperature (SST) imprints, central to mesoscale heat transports and eddy-atmosphere coupling, is provided for the Southern Ocean by analysing the relationship between satellite microwave SST and independent multi-altimeter sea surface height (SSH) observations, both at fixed-location and by directly following propagating mesoscale eddies based on automated tracking of their SSH anomalies.

At fixed location, SST variability is observed to feature narrow bands of enhanced mesoscale control anchored at major Antarctic Circumpolar Current (ACC) fronts, where intense eddies effectively stir surface isotherms. Large-scale processes, that dominate variability in the adjacent subtropical gyre interiors, are found to be non-negligible even here. Following eddies' tracks allows to detect transient mesoscale SST imprints that clearly stand out from this large-scale background even in quiet interiors.

The track-following analysis moreover reveals robust westward phase-shifts of eddies' SST anomalies with respect to their rotating cores. In energetic ACC regions the observed intense warm-top anticyclones and cold-top cyclones are only nearly in-phase, whereas in quiet regions weaker SST signatures are almost in quadrature with eddies' SSH. Consequentially propagating eddies flux heat poleward in the mixed-layer over a broad range of Southern Ocean regimes, with the ratio of rotational to divergent transports increasing towards energetic ACC regions. A composite eddy, typical of ACC conditions, is shown to transport $\sim 10^{12}$ W poleward in the mixed layer, an order of magnitude more than a typical eddy originating in the quiet regions. Whereas these local, baroclinic wave-type heat transports, consistent with the diffusive view, provide a complete picture for quiet interiors, scalings suggest that across major ACC fronts an additional non-local eddy heat transport mechanism is of zero-order importance.