Formation and transport of the South Atlantic Subtropical Mode Water in Eddy-Permitting Observations

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Intro

Mode water, a thick homogeneous layer formed by winter surface convection, represents regions of water mass formation in the world ocean (Hanawa and Talley, 2001).

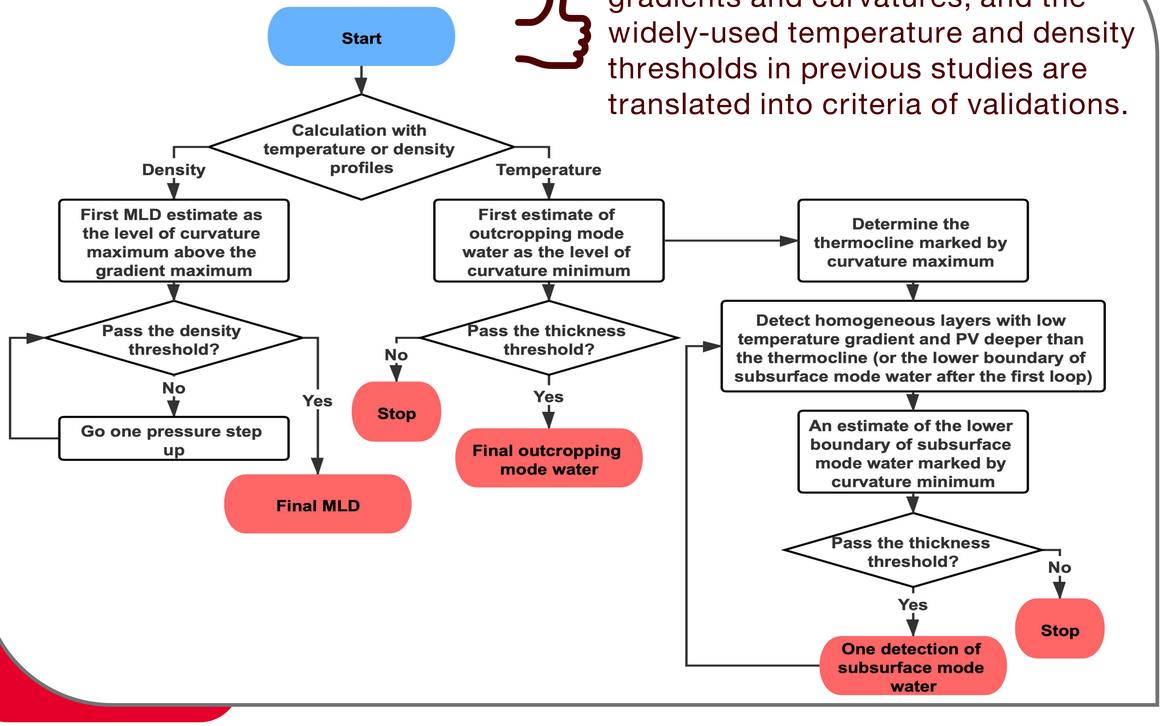
Serving as a heat (deficit) reservoir, mode waters modulate sea surface temperature anomalies and ventilate the thermoclines (e.g., Alexander et al., 1999, Dewar et al., 2005).

In this study, we develop a new algorithm to determine the mixed layer depth (MLD) and mode water thickness applied to the Argo global array. The detection is based on the gradient and second derivative (curvature) of each profile.

Then, we revisit the spatial and temporal evolution of the South Atlantic Subtropical Mode Water (SASTMW) and mainly make comparisons with Sato and Polito (2014).

Last, by co-locating ocean eddies derived from satellite altimetry (TOEddies, Laxenaire et al., 2018) with Argo profiles, we also assess the interplay between eddies and mode water transport.

Algorithm



The detection is dependent on gradients and curvatures, and the widely-used temperature and density thresholds in previous studies are translated into criteria of validations.

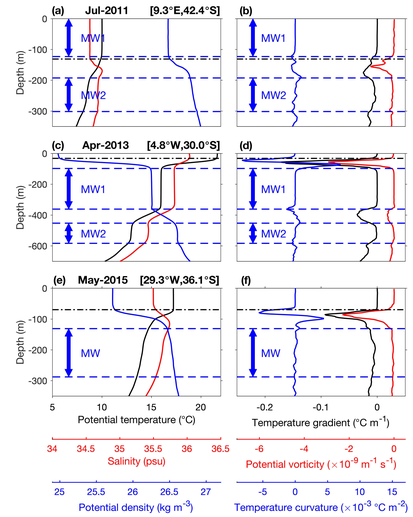


Fig 1. Three examples of MLD and mode water detection.

MLD and Mode Water

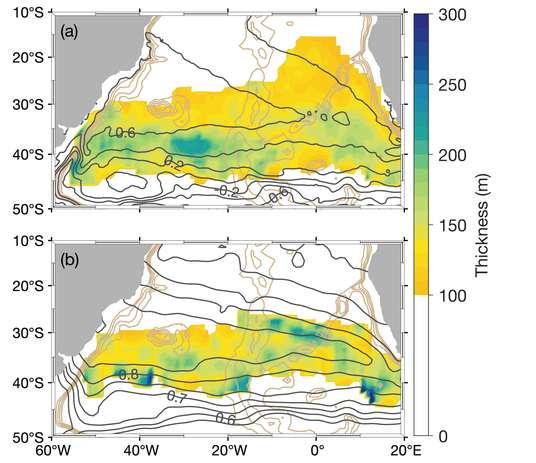


Fig 2. Outcropping and subsurface mode water thicknesses derived from the new algorithm.

Co-location with Eddies

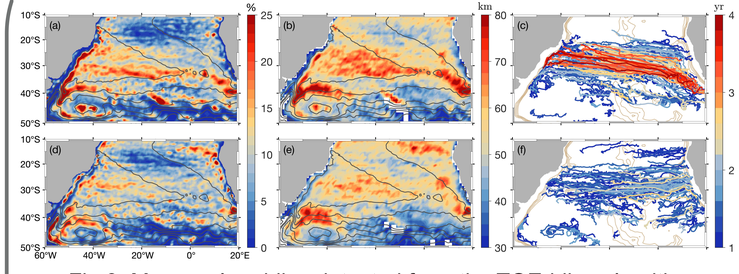


Fig 3. Mesoscale eddies detected from the TOEddies algorithm. Panels (a), (b) and (c) represent the anticyclonic eddy presence (in percentage), radius and trajectories of lifetime respectively. Panels (d), (e) and (f) indicate the same variables for cyclonic eddies.

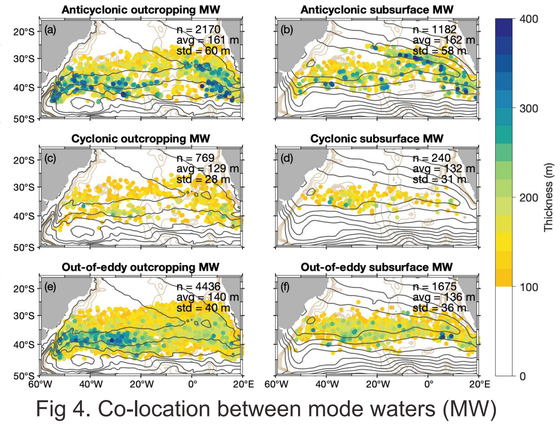


Fig 4. Co-location between mode waters (MW) and mesoscale eddies.

Take-home messages:

1. The new algorithm works better than traditional MLD detection methods to identify MLDs, especially compared with the gradient threshold method;
2. Two regions dominate as the mode water formation zones: i) Brazil-Malvinas Confluence; ii) Agulhas Leakage where anticyclonic Agulhas Rings are formed.
3. Anticyclonic eddies hold more mode waters than their cyclonic counterparts.