Effect of mesoscale eddies on subtropical mode water formation and ocean heat storage

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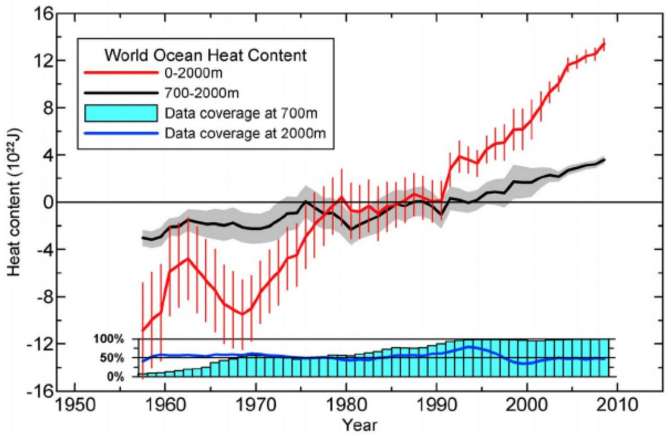
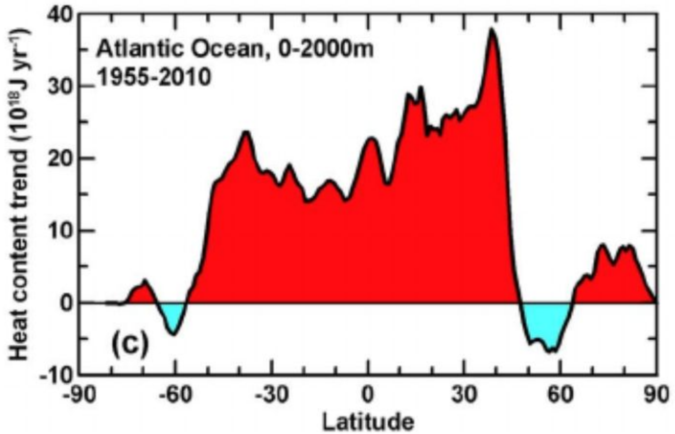
Outline

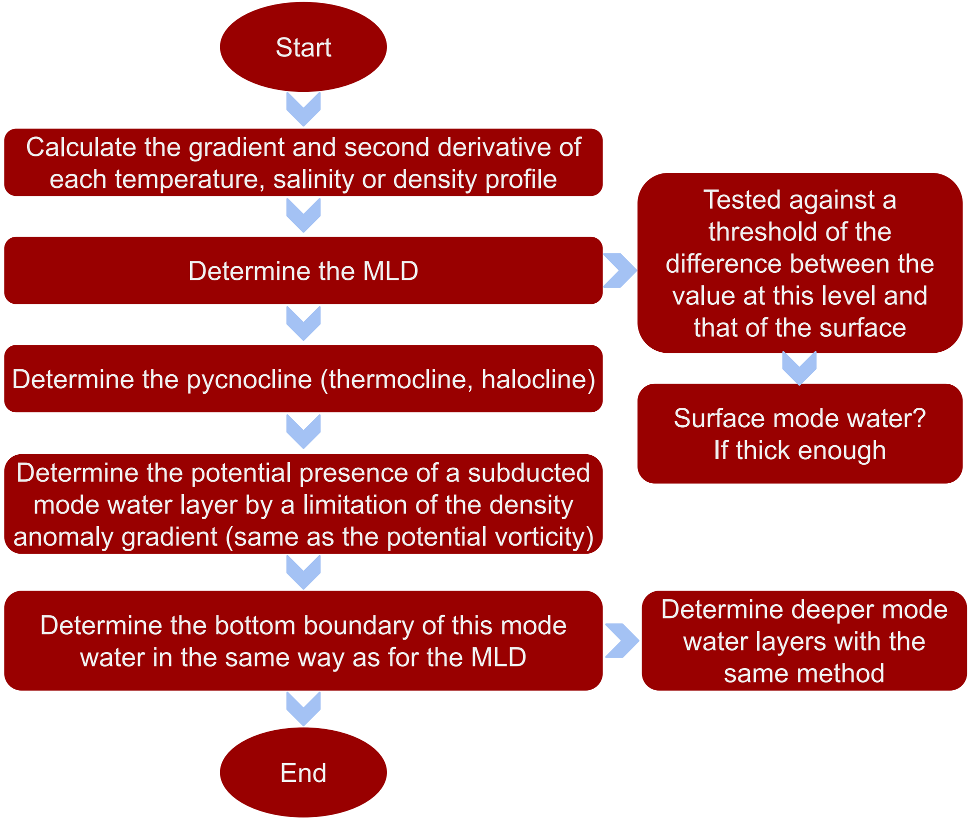
- ➢ Mode water plays a major role in the ocean heat uptake and serves as a heat reservoir that modulates surface temperature signals (Alexander et al., 1999).
- ➢ Here, we develop a new algorithm to determine the mixed layer depth (MLD) and mode water (MW) thickness applied to the Argo global array.
- ➢ Then, we revisit the spatial and temporal evolution of the South Atlantic subtropical mode water (SASTMW) following Sato and Polito (2014).
- ➢ By colocating mesoscale eddies from satellite altimetry using the newly developed TOEddies algorithm (Laxenaire et al., 2018) and Argo profiles, we also assess the role of eddies in SASTMW subduction and transport.

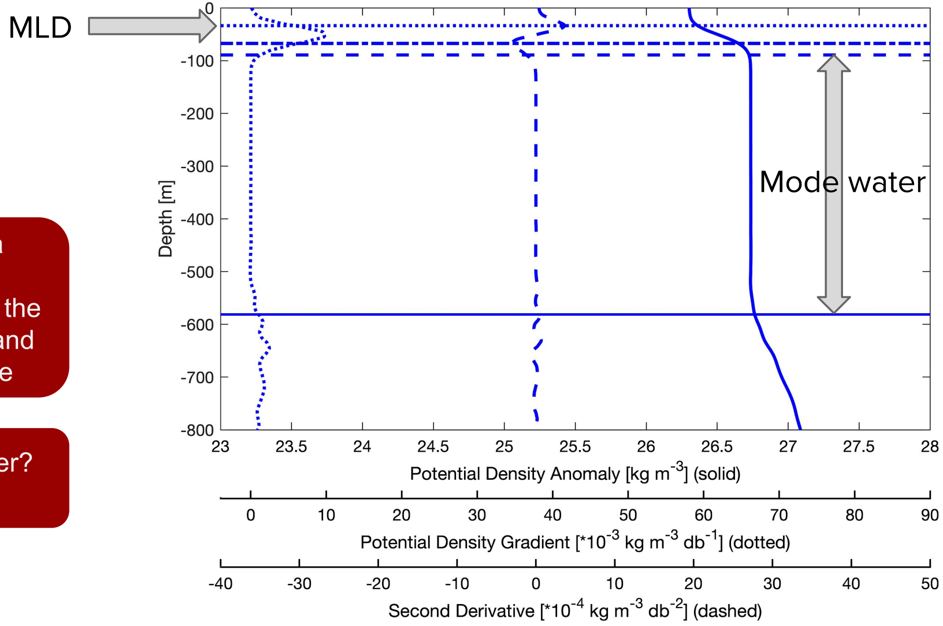




Levitus et al., 2012

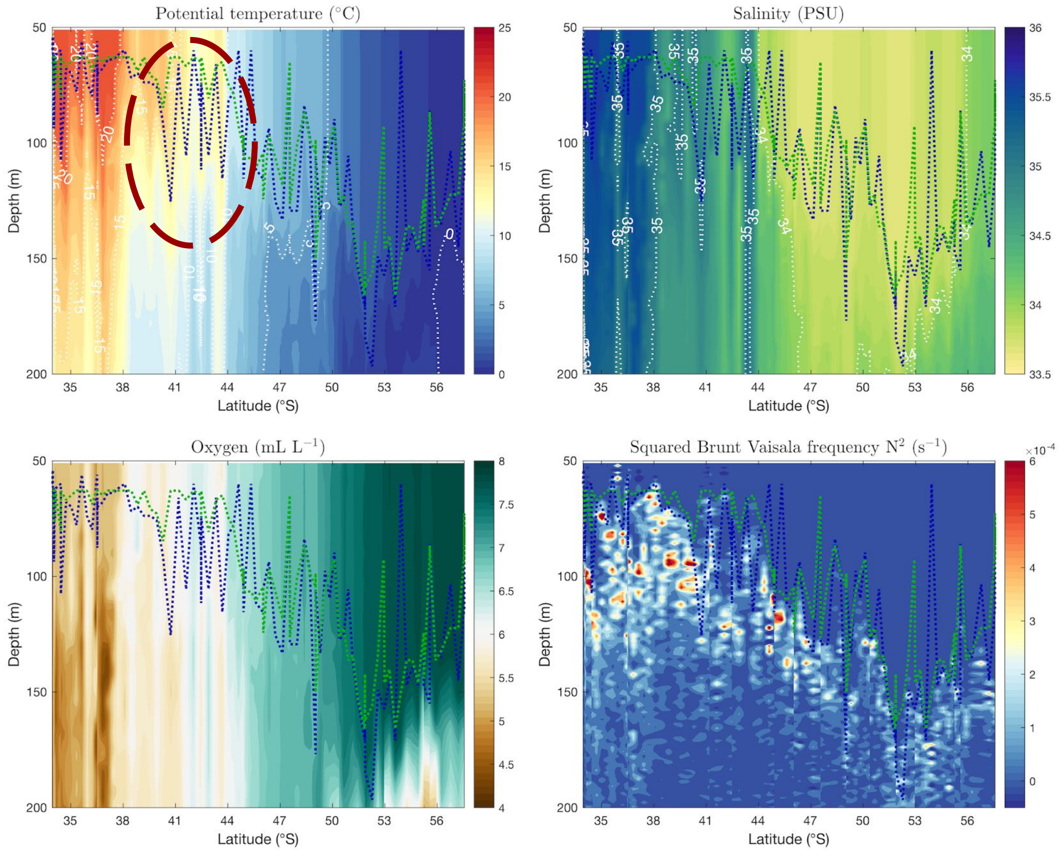
The Algorithm for MLD and MW detection





One Argo profile example: a thick subducted mode water layer associated with an anticyclonic eddy detected from satellite altimetry.

MLD definition: Application to the Good Hope section

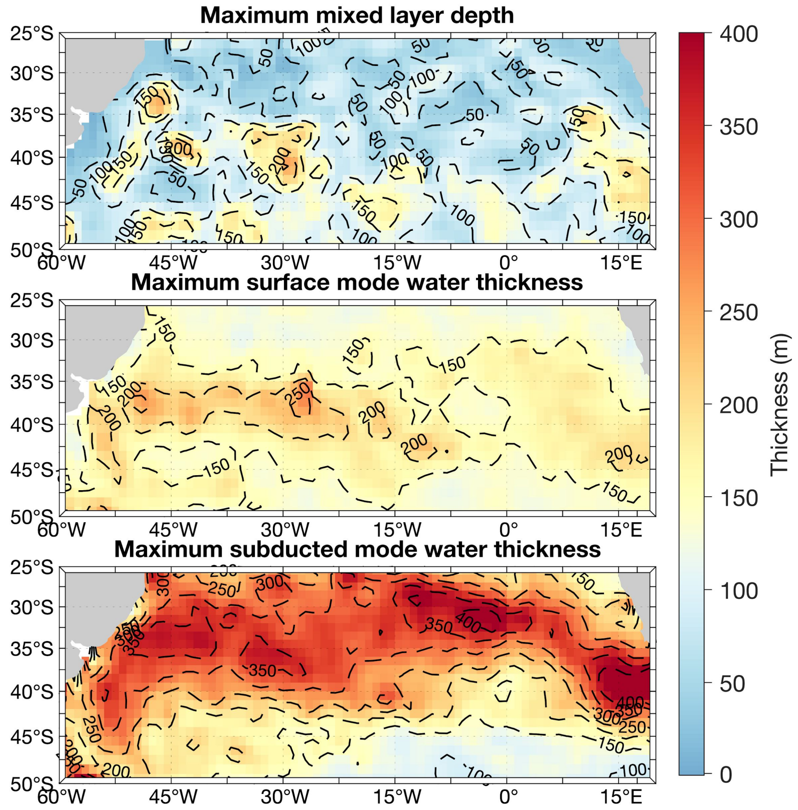


All methods are based on density gradient.

Green: Holte and Talley's method.

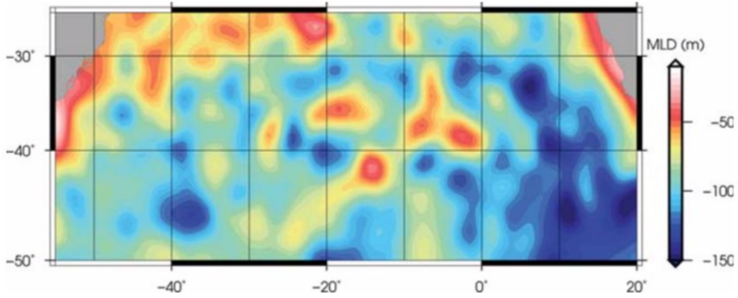
Blue: new combined method.

Application to the South Atlantic subtropics



Observe different hot spot regions of maximum MLD compared with other definition methods.

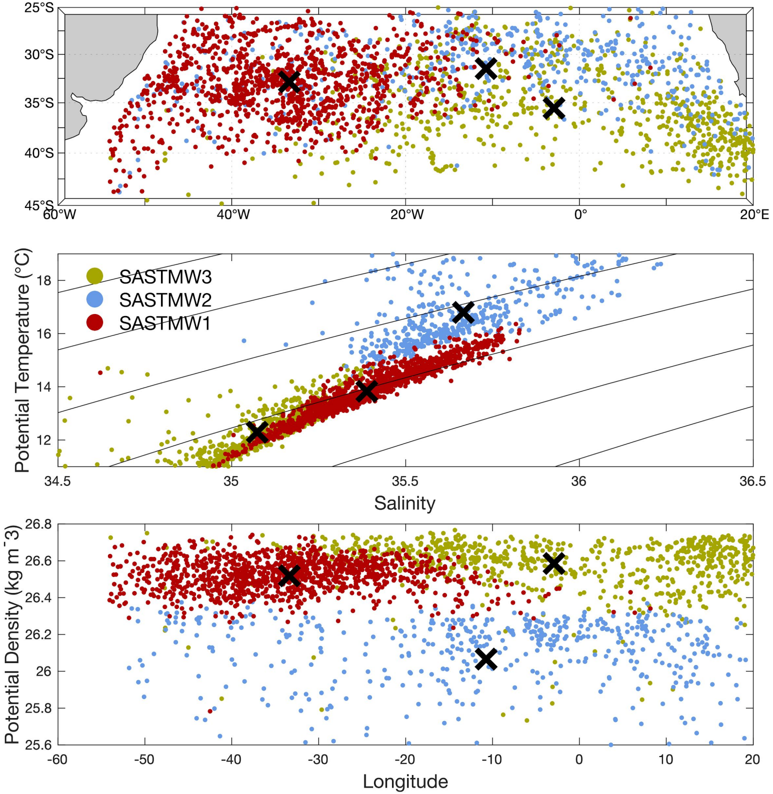
Maximum MLD obtained from Holte et al. (2010).

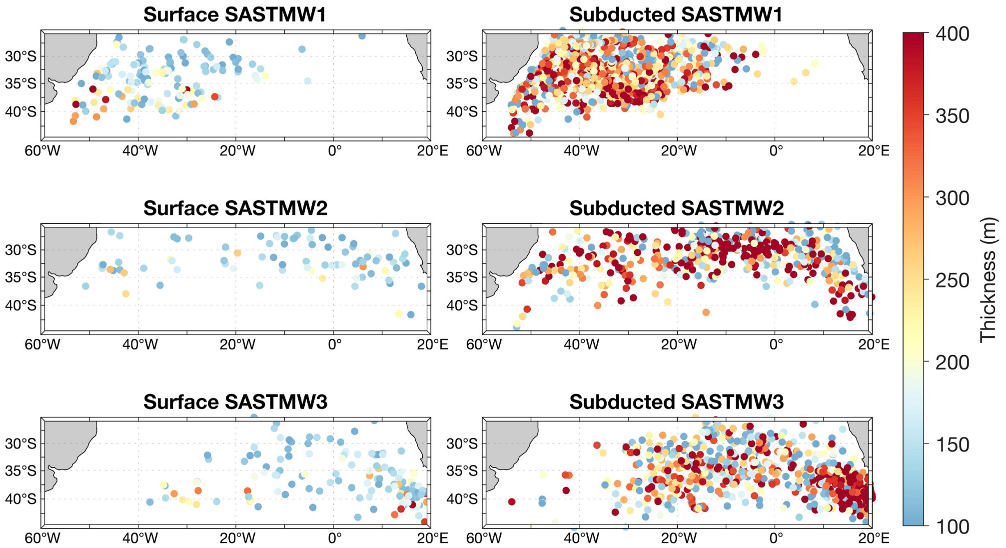


Also show the potential routes of water subduction and advection into the South Atlantic thermocline.

The Benguela and South Atlantic currents stand out as a major route for SASTMW.

Application to the South Atlantic subtropics



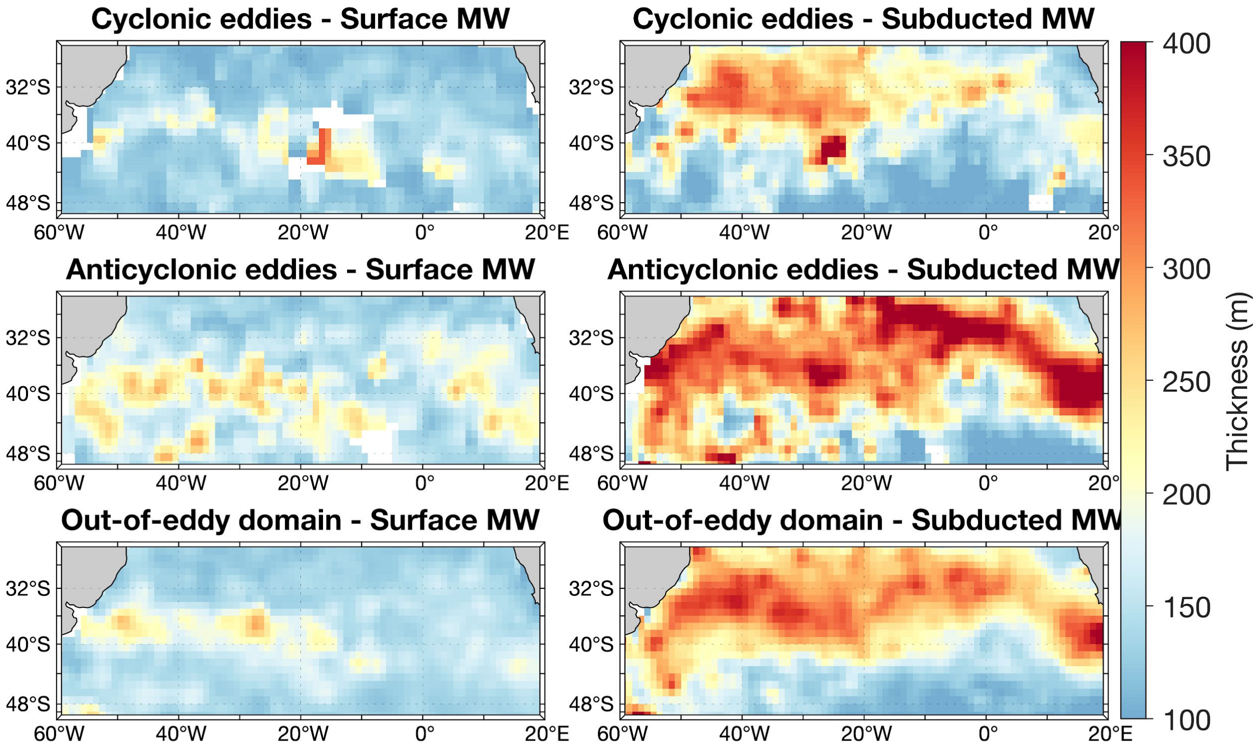


Three types of SASTMW following Sato and Polito (2014):

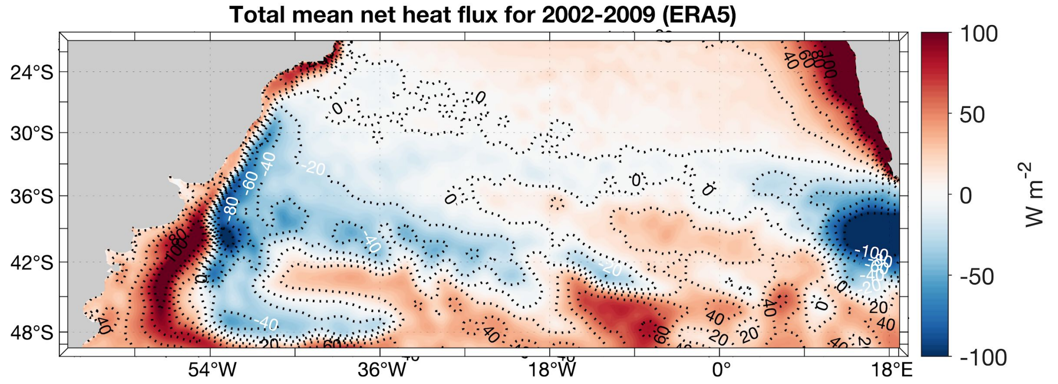
- SASTMW 1 is mostly concentrated in the western-half of the basin, contained between the South Brazil and South Atlantic Currents;
- SASTMW 2 occupies a broad area from the eastern side of the basin and reaches the western boundary;
- The denser subtropical mode water, SASTMW 3, is formed along the Subtropical Front.

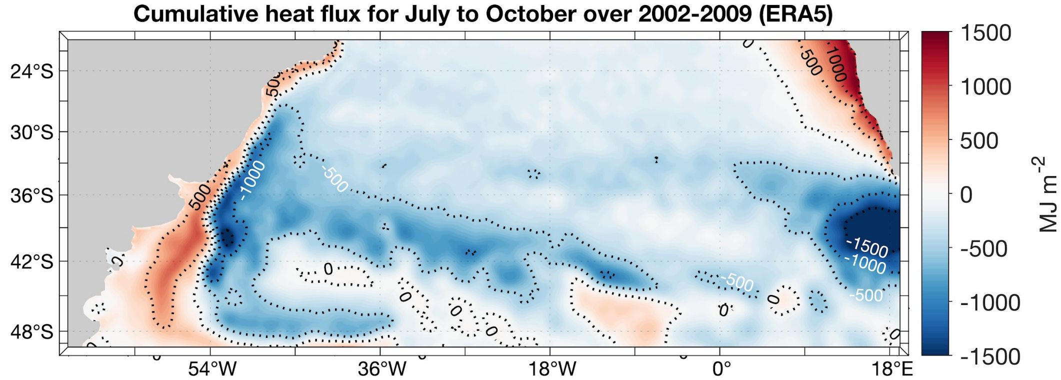
Application to the South Atlantic subtropics

- Colocate mesoscale eddies from the satellite altimetry (TOEddies algorithm from Laxenaire et al. 2018) and the Argo profiles.
- Mode water colocalized with anticyclonic eddies are thicker than that inside cyclones.
- A clear route of water subduction following the Benguela Current associated with anticyclones.
- Out-of-eddy domain may still contain non-tractable eddies.



Heat flux of the South Atlantic subtropics





Two regions strike as sites of net heat loss to the atmosphere.

One of these regions is located on the western side, in the Confluence region, where the Brazil Current encounters the northward flowing Malvina Current. As the western boundary current of the subtropical gyre, the BC carries warm waters along its southward path while it loses a large amount of heat to the atmosphere.

The second area with intense negative heat fluxes is on the eastern side, in the Cape Basin, promoted by the intrusion and retroflection of Indian Ocean waters through the Agulhas Current leakage.

Summary and future work

Validation by using both, CTD and Argo profiles, shows that the new algorithm to determine MLD and MW thickness works well in the South Atlantic region. Soon later, it will be applied to the global ocean.

This new algorithm is stricter than previous method to define mode water (a threshold of potential vorticity) but more reliable.

The colocalization between mesoscale eddies from satellite detection and Argo profiles makes it possible to evaluate the role of eddies in water subduction and transport.

In the South Atlantic subtropics, two regions noticeably stand out: one is associated with the confluence between the Brazil Current and Malvina Current on the western side of the basin; the other is in the Cape Basin, promoted by the intrusion of Indian Ocean waters through the Agulhas Current leakage.

Anticyclonic eddies carry more mode water than their counterpart cyclones. Some mesoscale eddies are not tractable from satellites, later will need more attention on this topic.

Thank you for your attention!