The South Atlantic subtropical mode water in eddy-permitting observations

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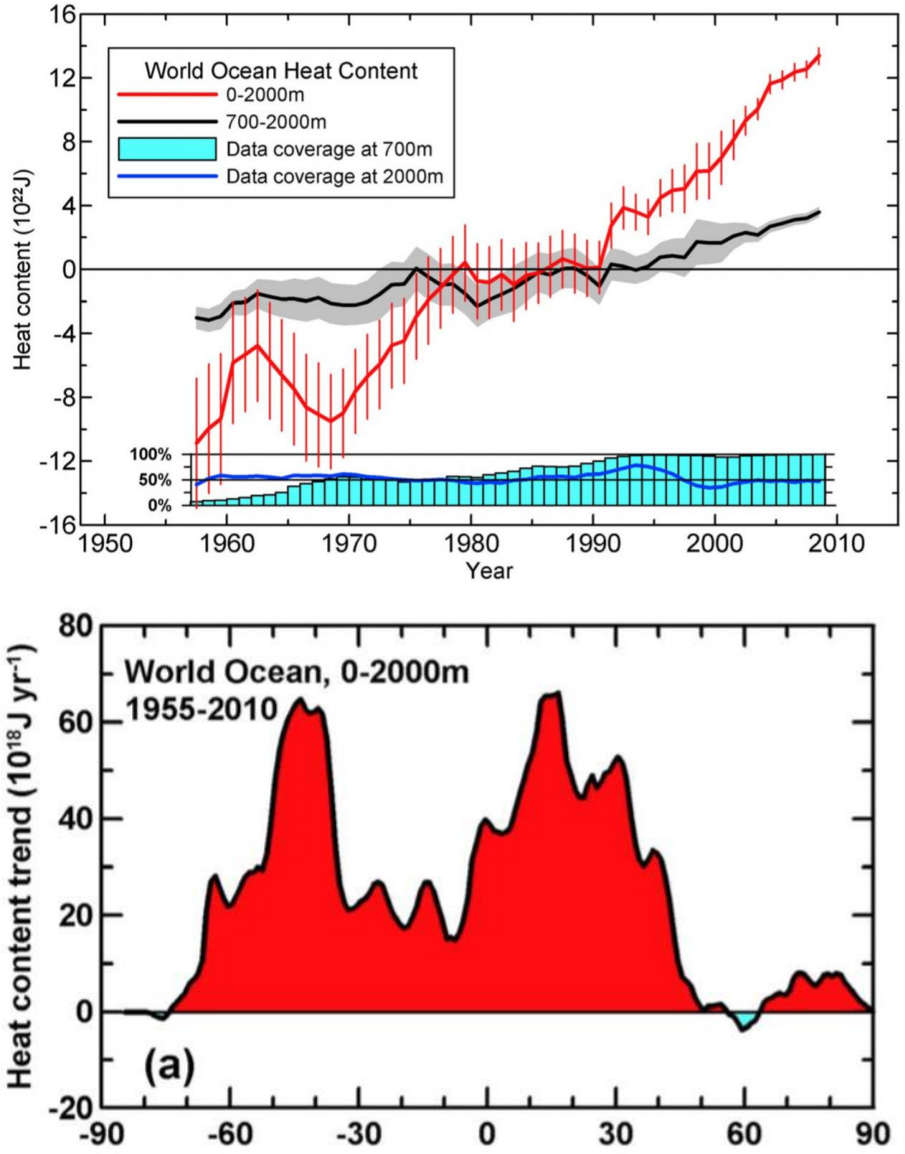
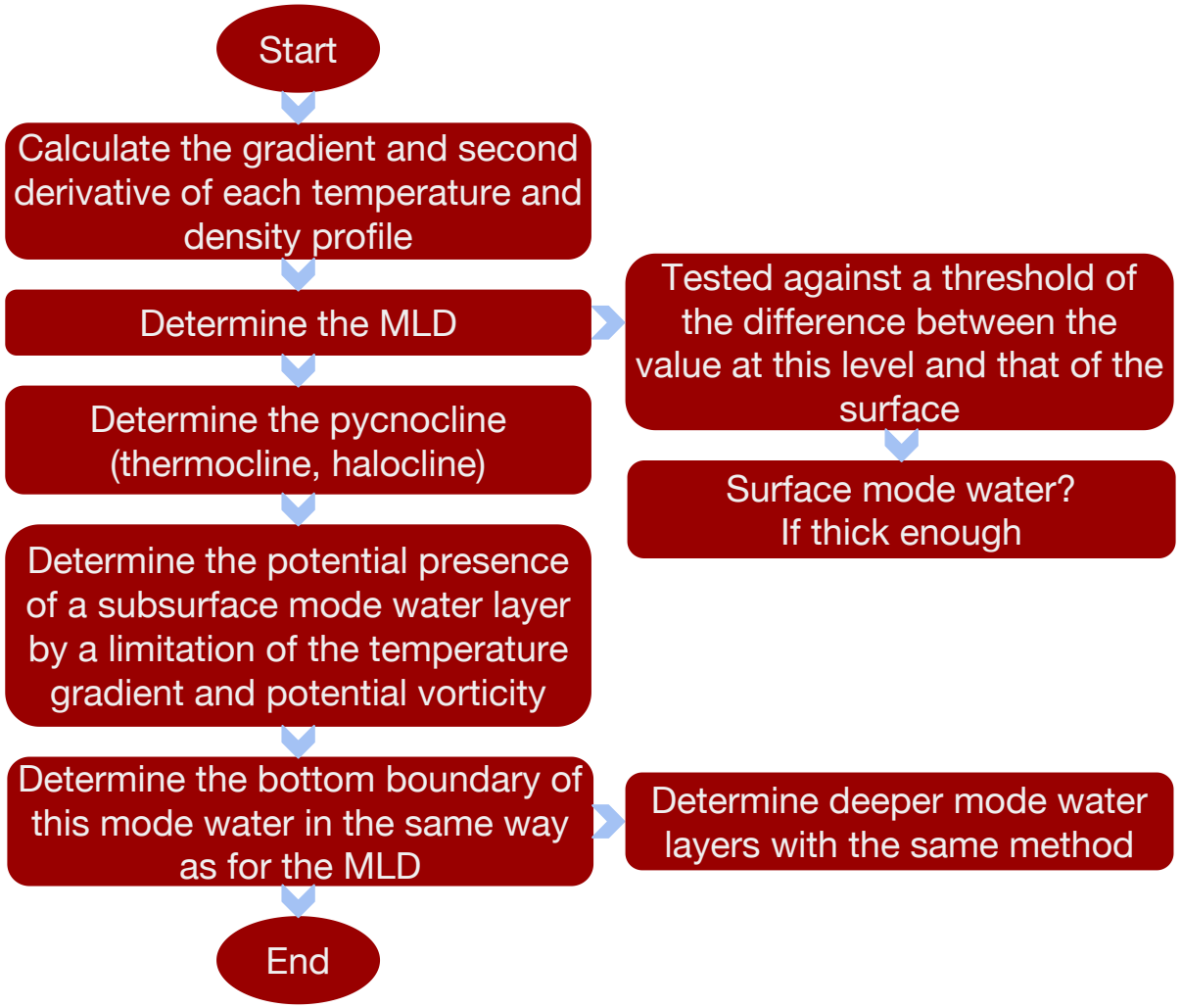
Outline

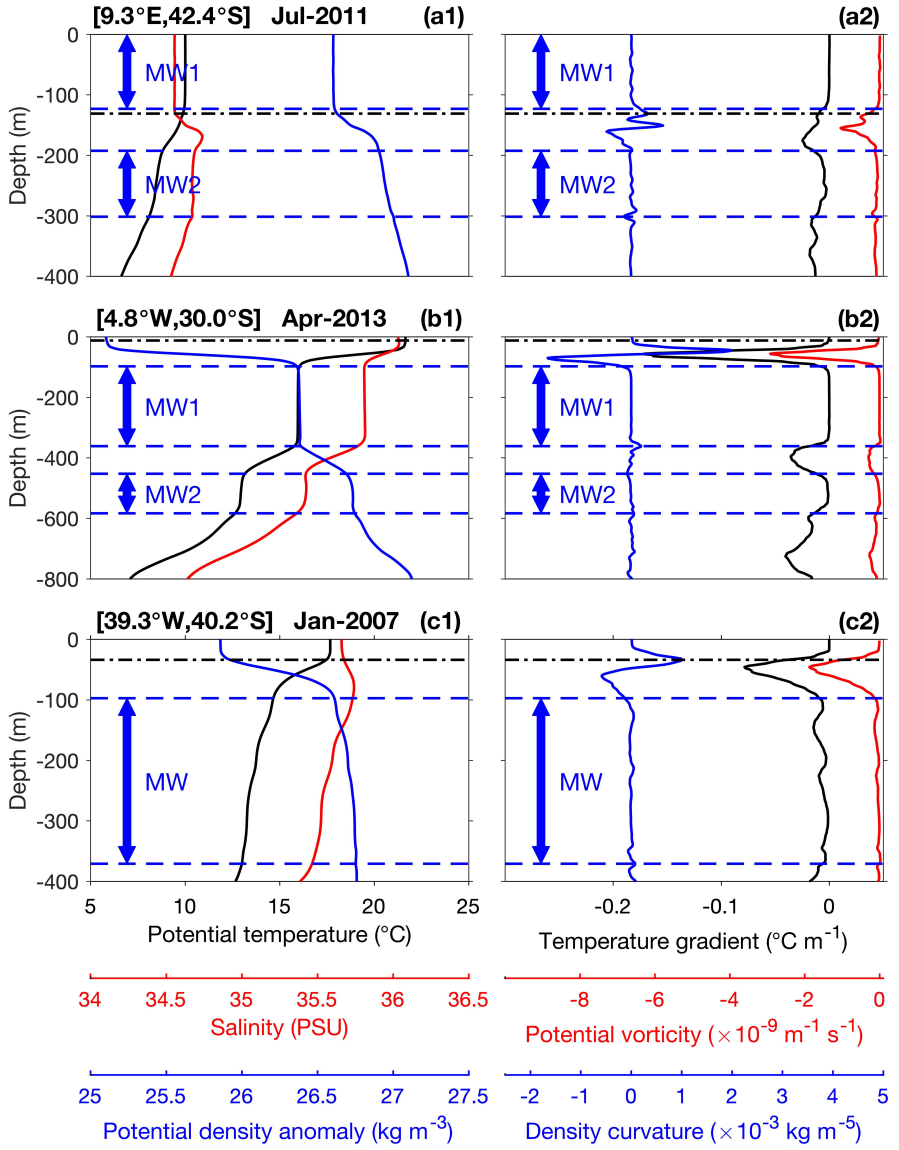
- Ocean serves as a heat reservoir of the Earth system, uptaking around 90% of the global warming.
- Mode water plays a major role in modulating the surface temperature signals (Alexander et al., 1999).
- Here, we develop a new algorithm to determine the mixed layer depth (MLD) and mode water (MW) thickness applied to the Argo global array.
- Then specifically, 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 mode water subduction and transport.



Ocean heat content (Levitus et al., 2012)

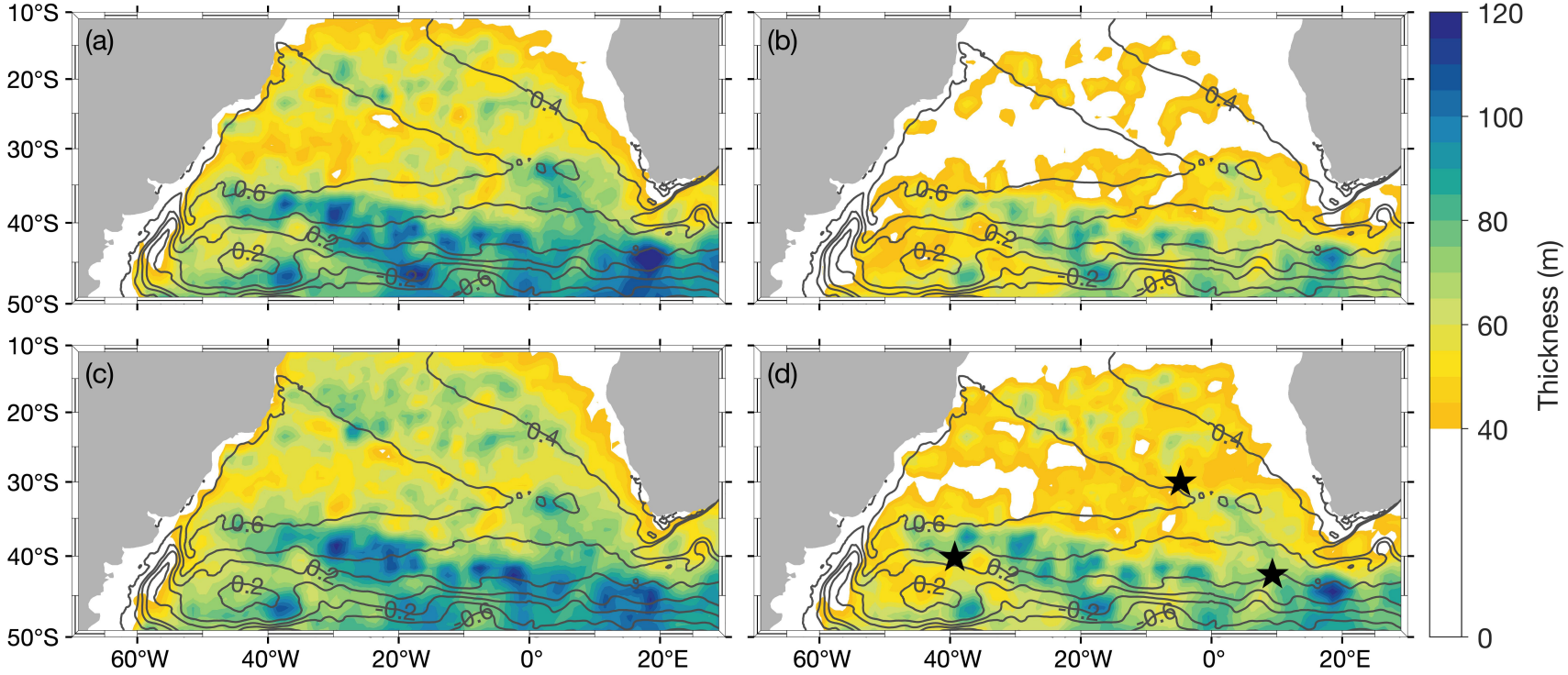
MLD and MW detection





Three Argo profile examples.

Comparison of MLD calculations



MLD calculations in the South Atlantic, identified by:

(a) Density threshold;

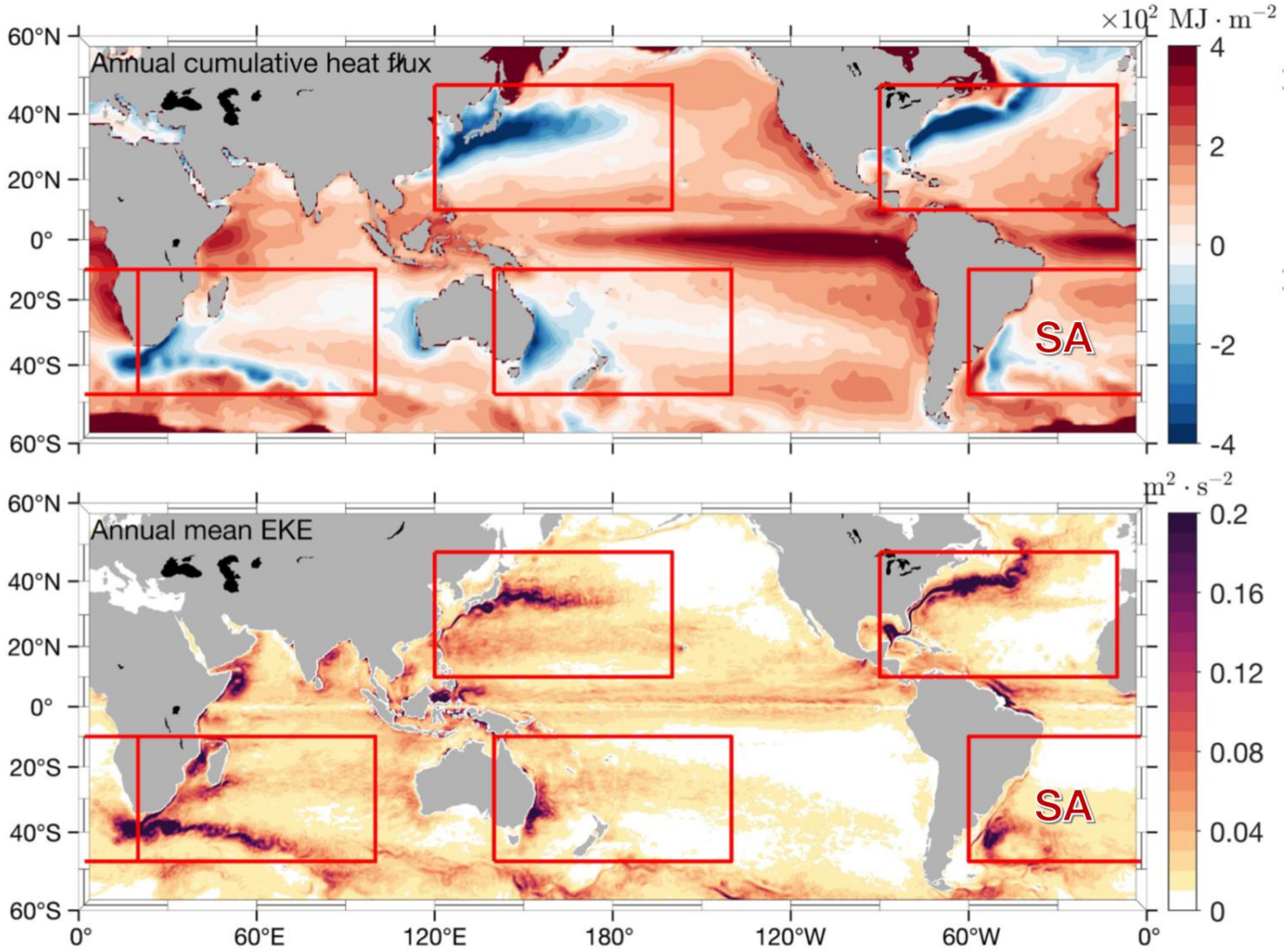
(b) Density gradient threshold;

(c) A hybrid method (Holte and Talley, 2009);

(d) The new algorithm (stars are the three examples in the previous slide)

- A uniform density threshold overestimates the MLD, while the application of density gradient threshold results in the shallowest estimate.
- In the subtropical regions where the seasonal cycle is weaker than its diurnal cycle, our detection by looking for the local extreme curvature can precisely trace the depth at which the gradient greatly changes.

Heat fluxes and the eddy kinetic energy



Global heat fluxes (positive downward) and EKE.

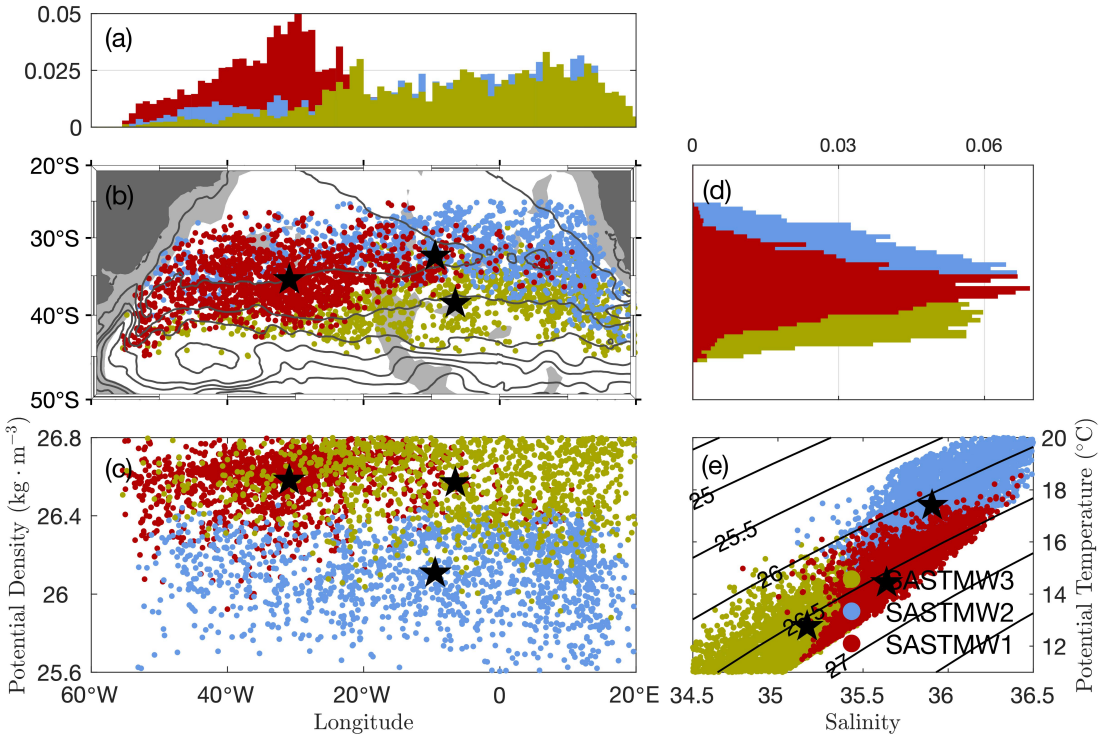
- The net heat loss coincides with western boundaries that are abundant of fronts and eddies.

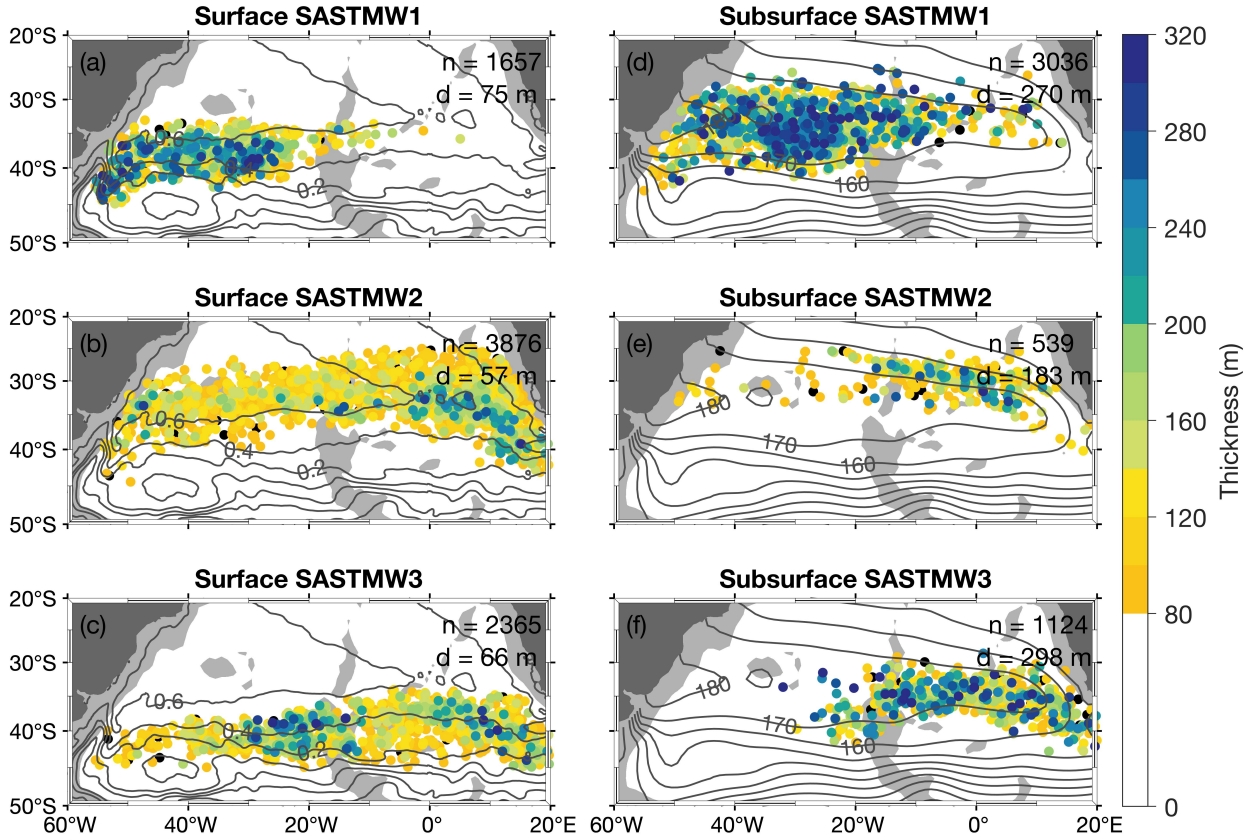
- The South Atlantic subtropics: two regions highlight as hotspots of heat loss.

--- One is located in the western side where the Brazil Current encounters the northward flowing Malvinas Current.

--- The second area with intense heat loss is on the eastern side where the Indian Ocean waters enter through the Agulhas Current leakage.

SASTMW cluster analysis





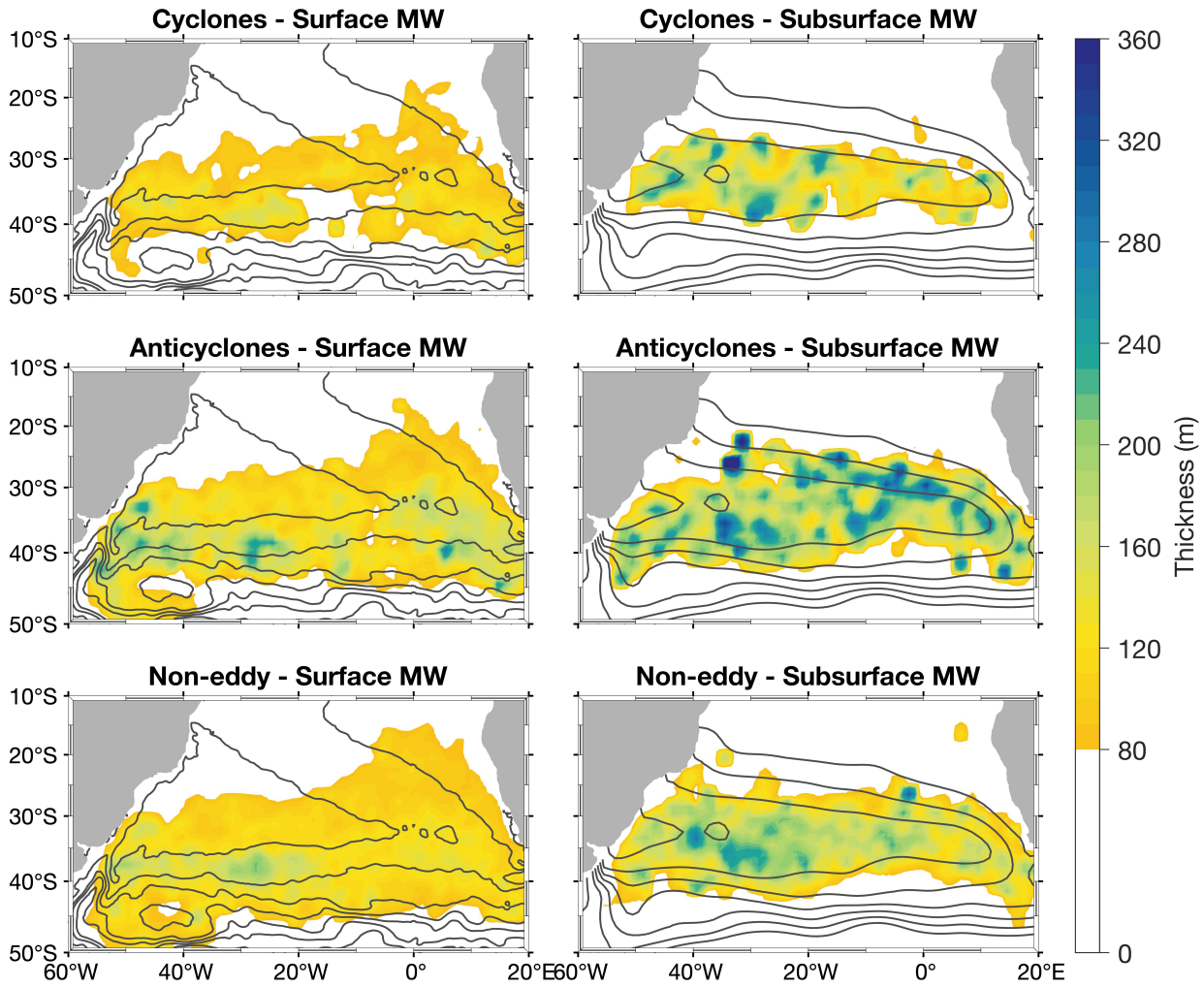
Three clusters of SASTMW.

Three types of SASTMW:

- SASTMW1 is mostly concentrated in the western-half of the basin, contained between the South Brazil and South Atlantic Currents;
- SASTMW2 occupies a broad area from the eastern side of the basin and reaches the western boundary;
- SASTMW3 is the densest type, formed along the subtropical front or the southern branch of eddy trajectories from the Agulhas leakage.

Colocation of MW with eddies

- 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 route of water subduction following the Benguela Current associated with anticyclones.
- Out-of-eddy domain may still contain non-tractable eddies.



Colocation between mode waters and eddies

Take home messages and future work

- A new algorithm is developed to identify mixed layer depth and mode water layers based gradients and curvatures of individual Argo profile.
- This new algorithm is more strict than previous methods to define mode water (only 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 waterer subduction and transport.
- In the South Atlantic subtropics, two regions noticebly stand ouut: one is associated with the confluence region 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 waters than their cyclonic counterparts. Some mesoscale edidies are not tractable from satellites after subduction. Later we will need more attention on this topic.

Thank you for your attention.