

Colder and smaller : 10 years of observations of surface salinity by SMOS, Aquarius and SMAP to study mesoscale eddies in the Southern Ocean

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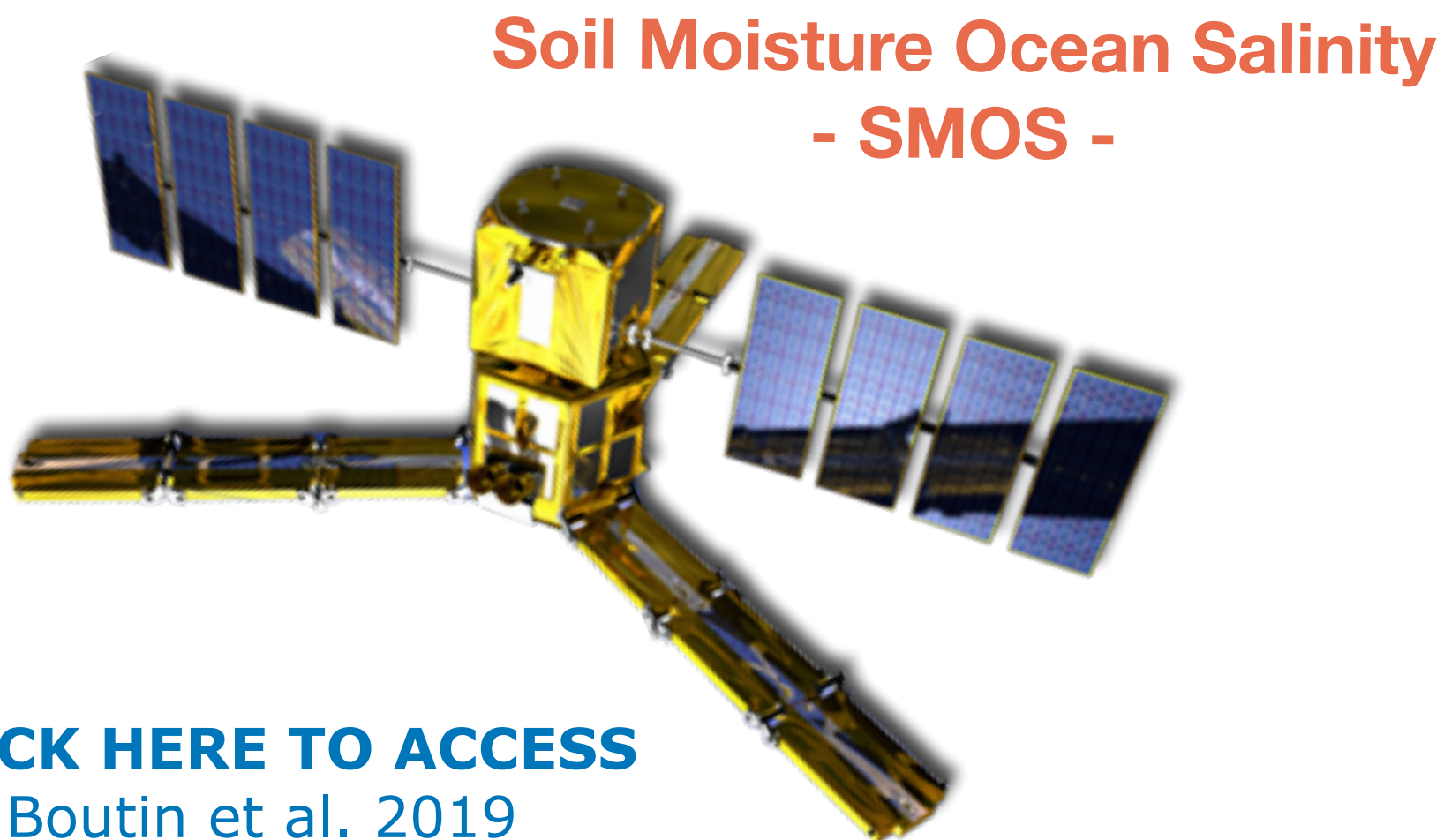


Take Home Messages

The analysis of surface salinity reveals the **erosion of subsurface waters**, such as mode waters, induced by changes in **vertical mixing** caused by the deep reaching eddies in the Southern Ocean.

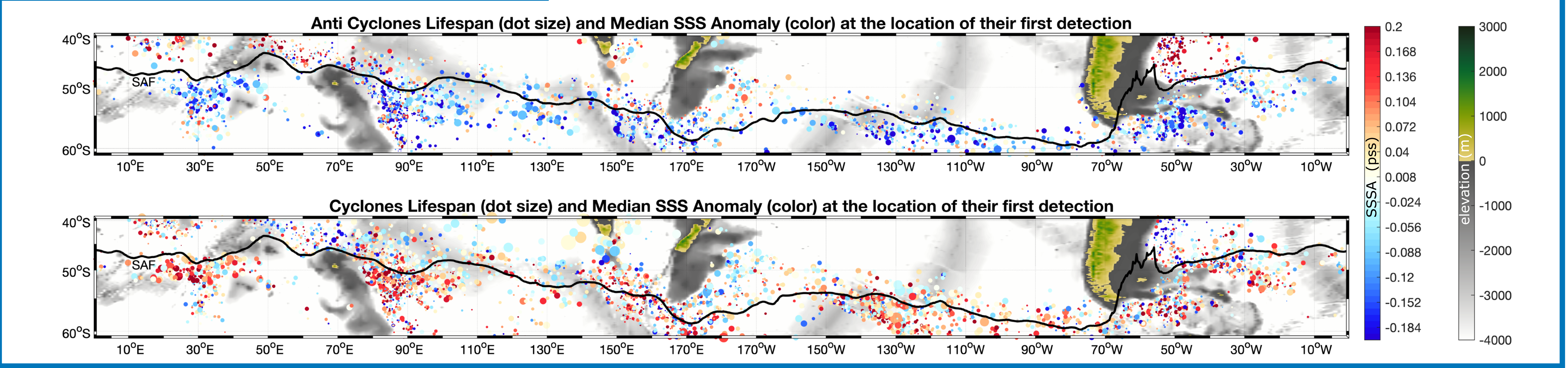
Since 2010, space missions dedicated to **Sea Surface Salinity (SSS)** have been providing observations with a **resolution of about 45 km every 3 days**. The European Space Agency (ESA) SMOS mission was the first orbiting radiometer to collect regular SSS observations from space.

Most SSS satellite-based studies have left out the Southern Ocean because of its **lower sensibility in rough and cold waters**. **New processing** now allows a **better SSS estimate** at high latitudes.

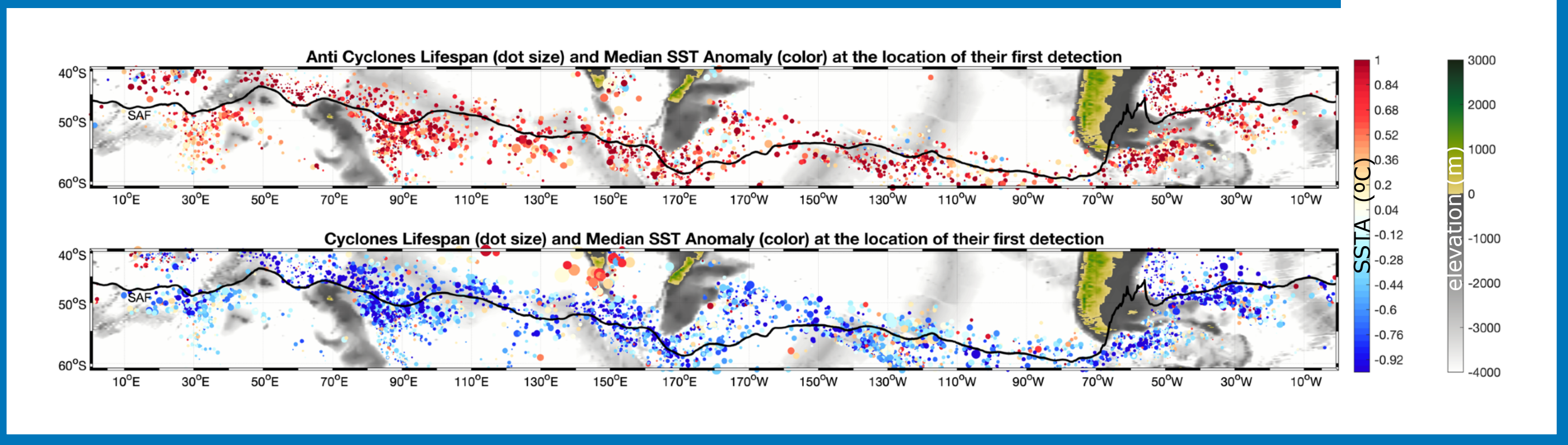


CLICK HERE TO ACCESS
Boutin et al. 2019
2010-present v4 dataset
available at seanoe.org

Sea Surface Salinity Anomalies



Sea Surface Temperature Anomalies



Anomalies

Robust SSS signal depending on :

- the eddies **rotation** (cyclone/anticyclone)
- latitudinal position with respect to the **SAF** (meanders permitting weekly SAF position)

Latitudinal dependence **not found in SST**.

These observations reveal the **interaction of eddies** with the **larger scale water masses** :

- cold (warm) surface waters south (north) of SAF
- fresh (saltier) surface waters south (north) of SAF
- warm (cold) over warm (cold) waters south (north) of SAF
- fresh (saltier) over saltier (fresh) waters south (north) of SAF

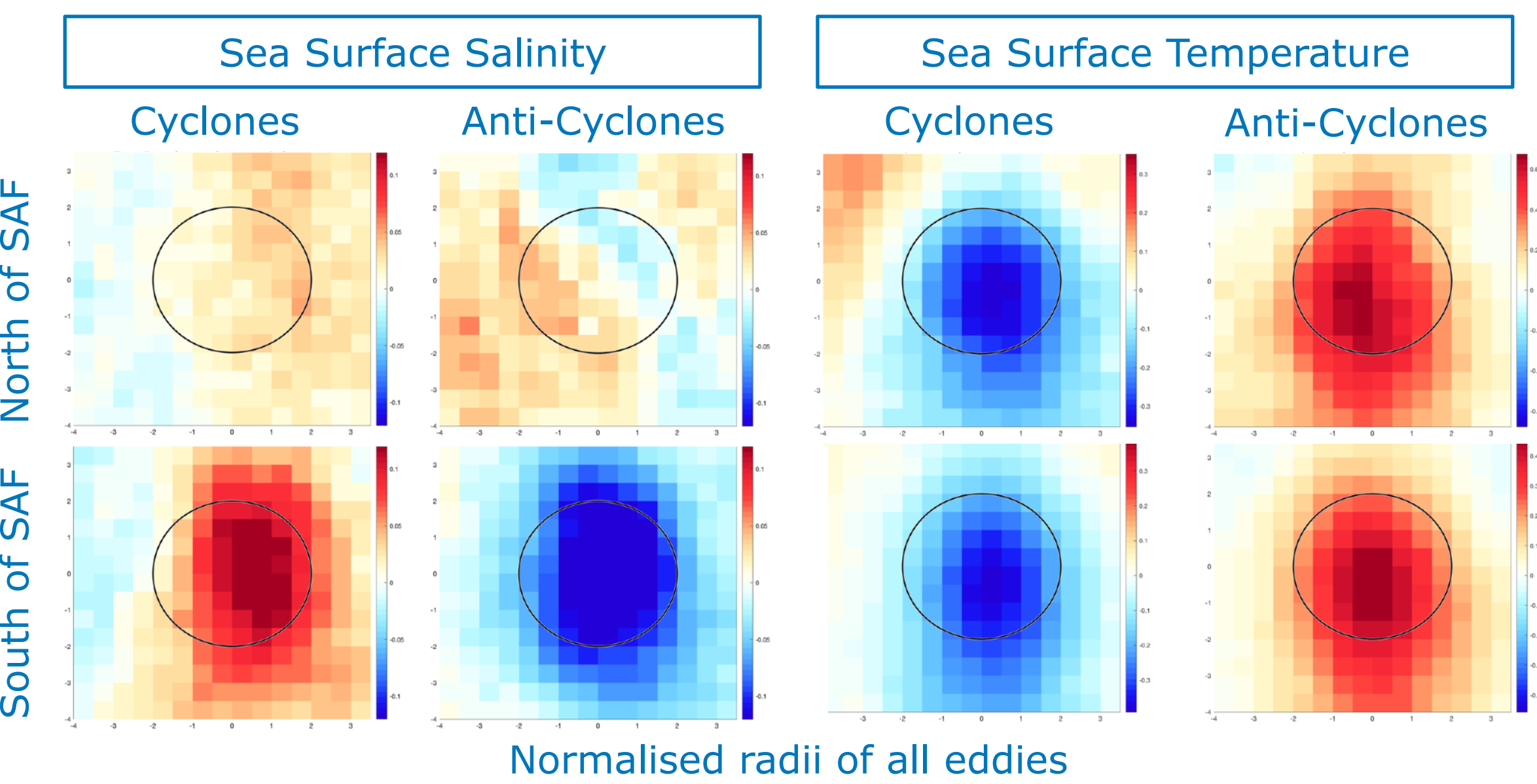
Computed following Hasson et al. 2019 methodology

Composites

Different **patterns in SSS and SST anomalies composites** :

- bi-poles linked with **horizontal stirring** of fronts,
- mono-poles from **trapping** water or **vertical mixing** changes
- a combination of the two.

Strong SSSA dipole Cyclones consistent with latitudinal SSS gradient
SSSA and SSTA monopoles not consistent with latitudinal gradients
-> **vertical mixing must be one of leading processes**



Anomalies averaged at the eddies center is not significant for dipoles.

Interactions with subsurface waters

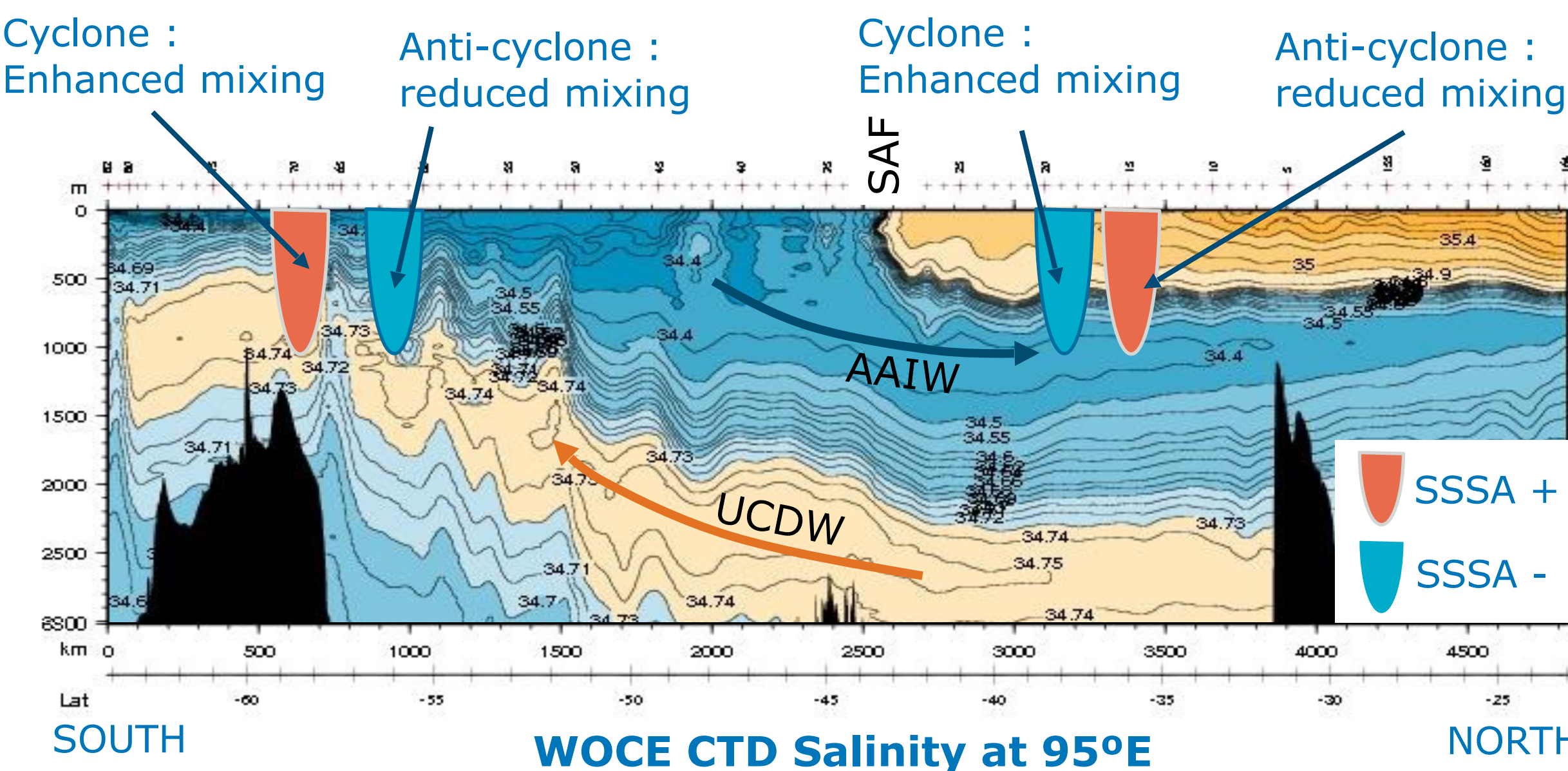
Vertical displacement of isopycnals associated with eddies :

-> **enhanced (reduced) mixing** in the case of **cyclonic (anticyclonic) eddies**

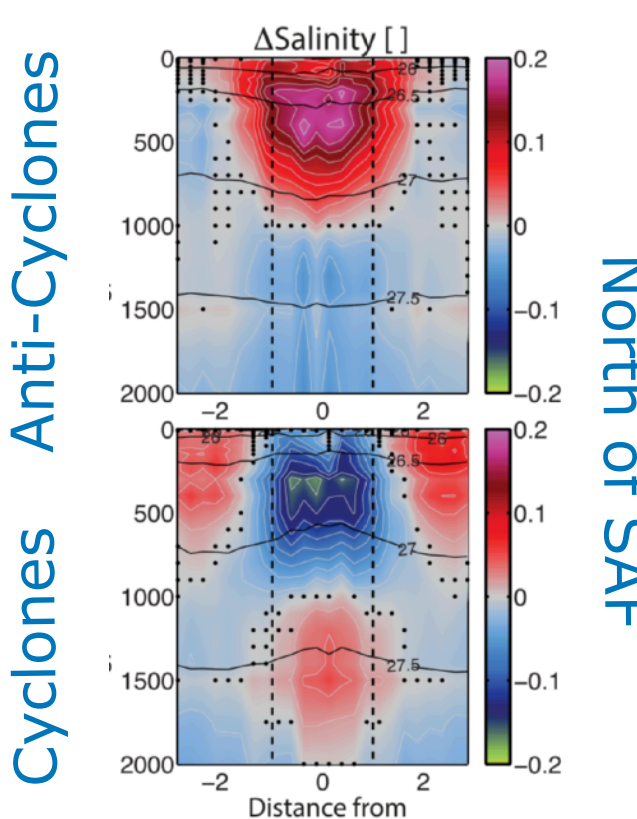
Eddies of the Southern Ocean are reaching **very deep** : deeper than 1000 m (Frenger et al. 2015)

S and T **vertical structures** south (north) of the SAF are **consistent with SSSA and SSTA** found south (north) of the SAF

-> **Interaction between eddies and subsurface waters** such as winter waters, the UCDW or AAIW



Salinity Anomalies



Frenger et al. 2015

Datasets

Sea Surface Salinity (SSS) : SMOS 9d 'Debias' v4 (CATDS) catds.fr

Finite Lyapunov Singular Exponents (FLSE) : Aviso product based on SLA (d'Ovidio et al., 2004) distributed by CLS

Eddies : Sept 2019 ADT based Aviso product distributed by CLS based on (Mason, Pascual, and McWilliams, 2014)

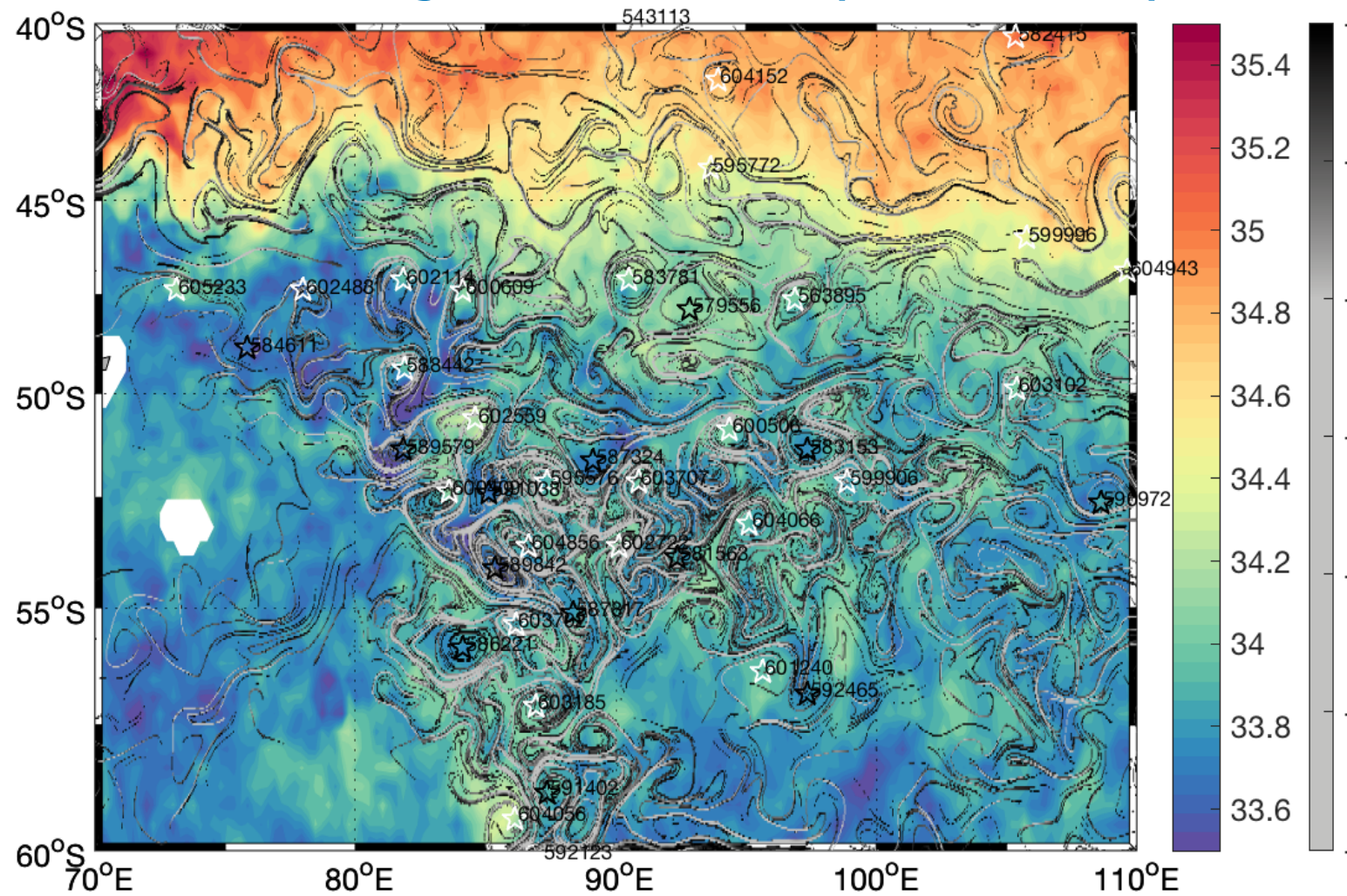
Sea Surface Temperature (SST) : Ostia (UKMO-L4_GHRSST-SSTfnd-OSTIA-GLOB-v02.0)

ACC fronts : 2019 product allowing meanders developed by CTOH/LEGOS

Acronyms : **SAF** : Sub-Antarctic Front
SSSA/SSTA : SSS/SST Anomaly

AAIW : Antarctica Intermediate Waters
UCDW : Upper Circumpolar Deep Waters

Matching FSLE and Detected Eddies around the Kerguelen Plateau (03 15 2011)



References

Boutin, J., J.L. Vergely, C. Thouvenin-Masson, A. Supply, D. Khvorostyanov, (2019). SMOS SSS L3 maps generated by CATDS CEC LOCEAN debias V4.0. SEANOE, <https://doi.org/10.17882/52804#69293>.

Frenger, I., M. Munnich, N. Gruber, and R. Knutti (2015), Southern Ocean eddy phenomenology, J. Geophys. Res. Oceans, 120, 7413–7449, doi:10.1002/2015JC011047.

Hasson, A., Farrar, J. T., Boutin, J., Bingham, F., & Lee, T. (2019). Intraseasonal variability of surface salinity in the eastern tropical Pacific associated with mesoscale eddies. Journal of Geophysical Research: Oceans, 124, 2861–2875. <https://doi.org/10.1029/2018JC014175>

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