

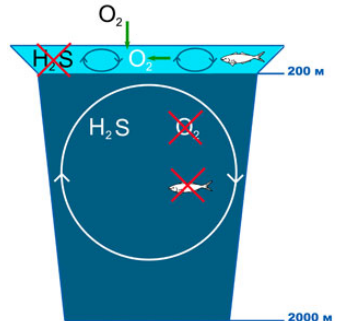
Potential for Composite Analysis in the Black Sea

Arthur Capet¹, Mason E.², Troupin C.²,
Vandenbulcke L.¹, Ananda Pascual² Grégoire M.¹

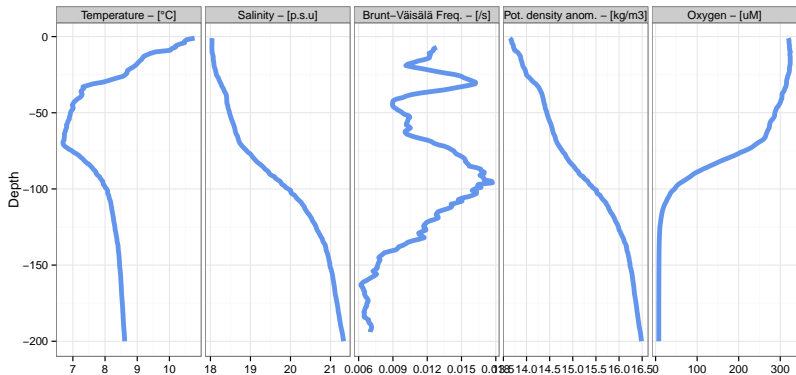
¹MAST, University of Liège, Liège, Belgium

²IMEDEA, Balears, Spain

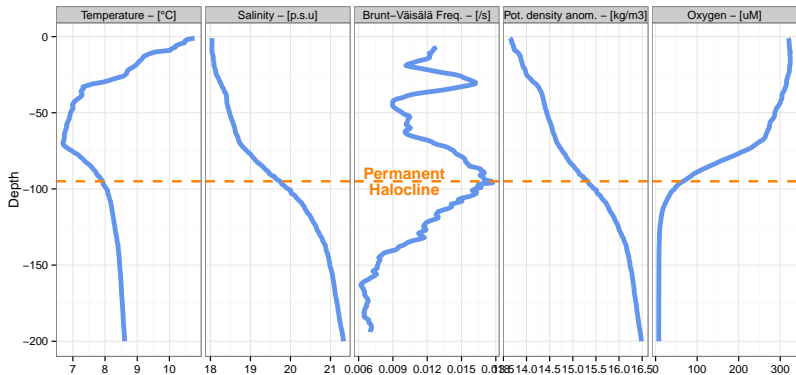
The Black Sea : Unique !



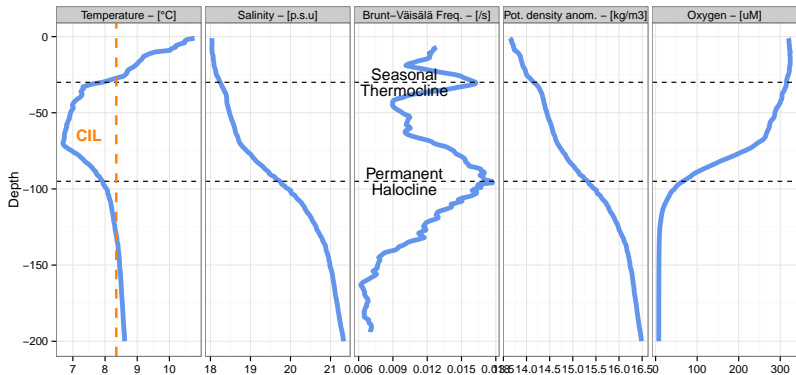
Vertical structure



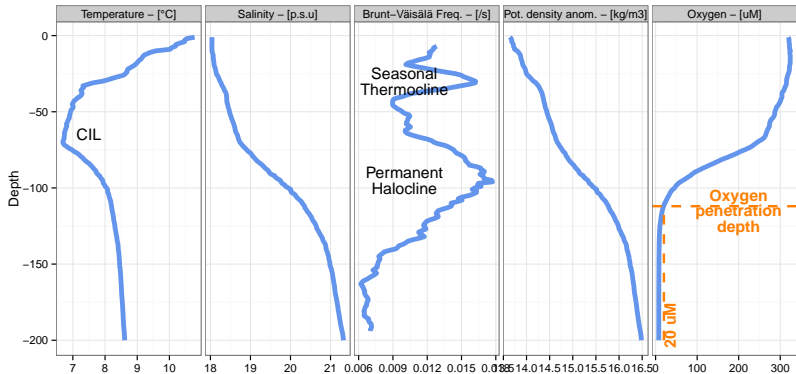
Vertical structure



Vertical structure



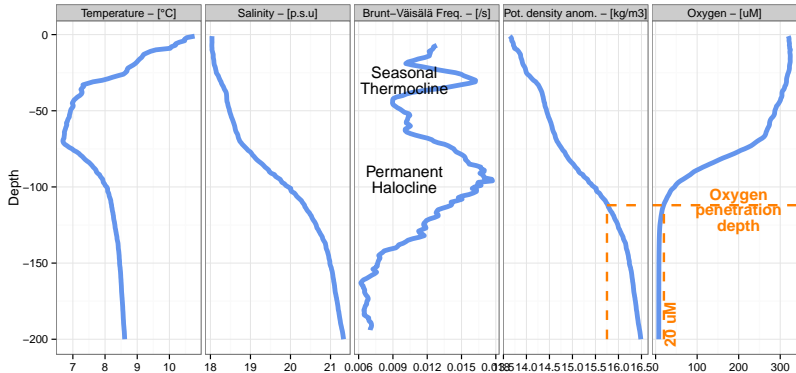
Vertical structure



Diagnostics of oxygen vertical structure

- ▶ Oxygen penetration depth
- ▶ σ_θ at oxygen penetration depth
- ▶ oxygen inventory

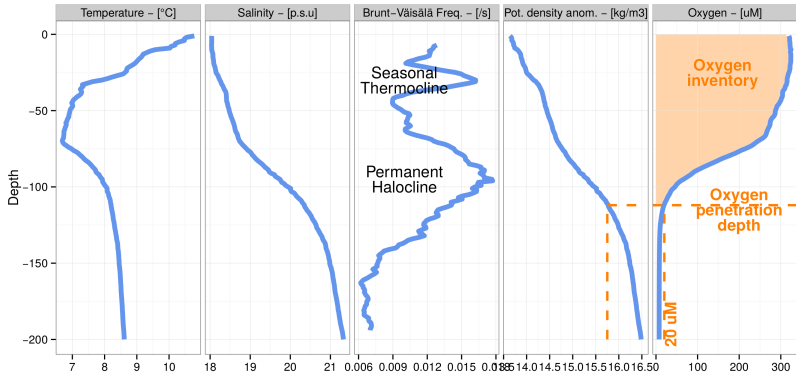
Vertical structure



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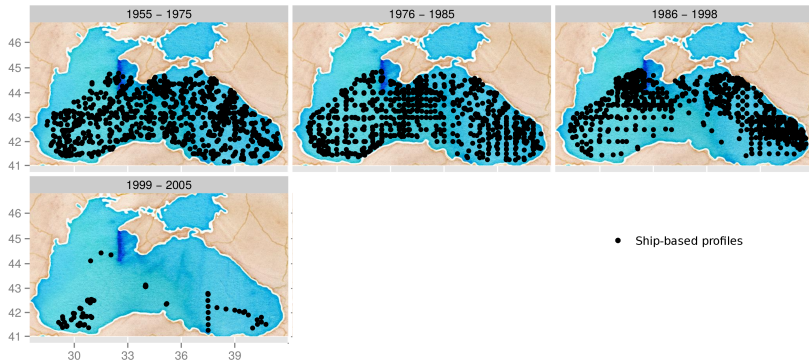
Vertical structure



Diagnostics of oxygen vertical structure

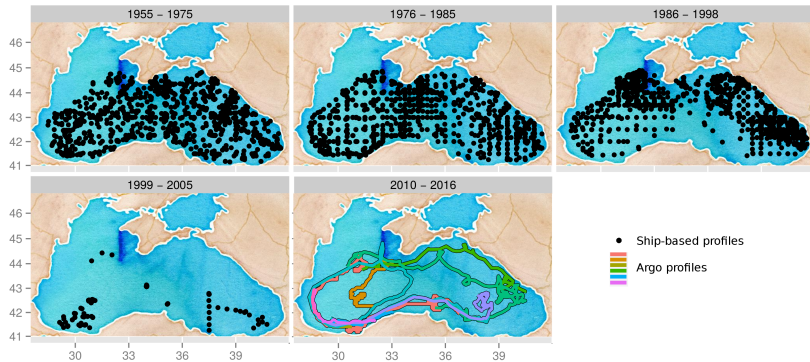
- ▶ Oxygen penetration depth
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Profiles Data



- ▶ World Ocean database, R/V KNORR 2003, R/V Endeavour 2005
- ▶ Argo

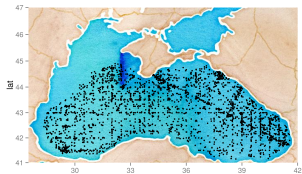
Profiles Data



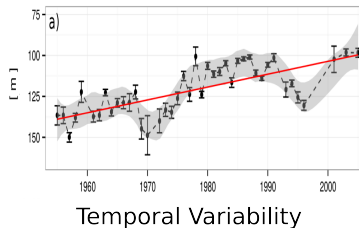
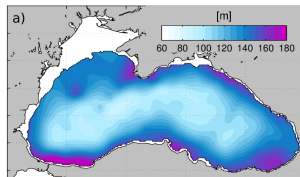
- ▶ World Ocean database, R/V KNORR 2003, R/V Endeavour 2005
- ▶ Argo

Detrending

Data



Spatial Variability



Data Interpolation Variational Analysis + detrending algorithm

Capet et al. 2014, Ocean Dynamics

Deoxygenation Trends : 1955 → 2015

Oxygen penetration depth

140m

→

90 m

Oxygen penetration σ_{θ}

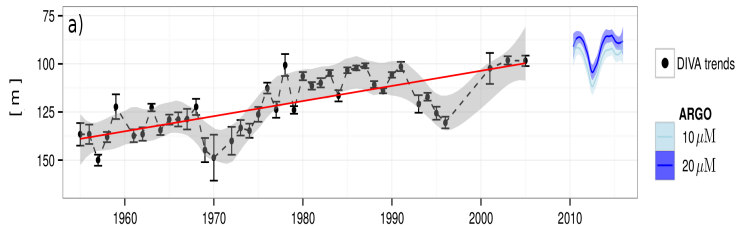
16.05 kg m⁻³

→

15.4 kg m⁻³

Oxygen inventory

-44%



Deoxygenation Trends : 1955 → 2015

Oxygen penetration depth

140m

→

90 m

Oxygen penetration σ_θ

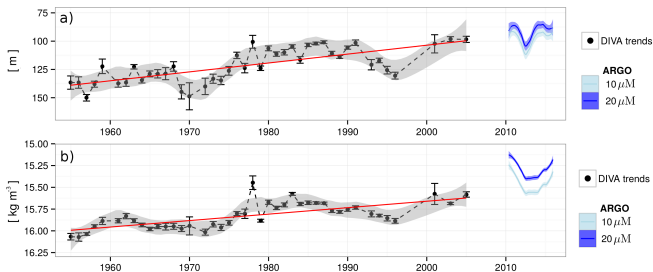
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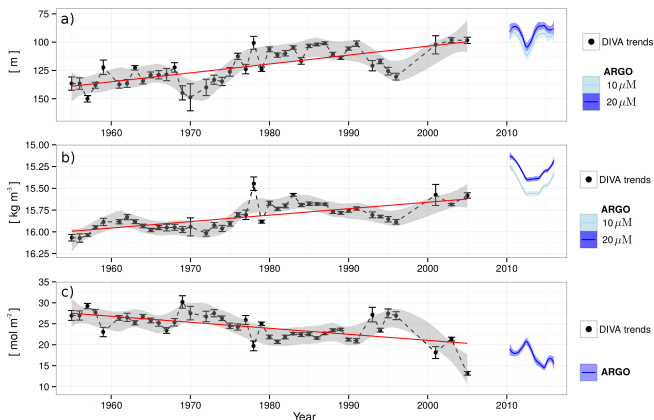
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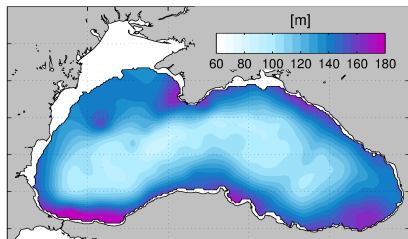
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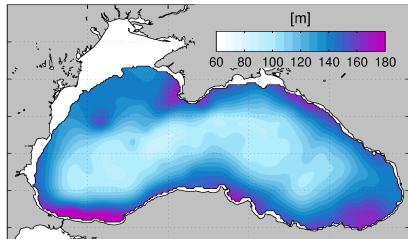
Spatial variability

Oxygen penetration depth

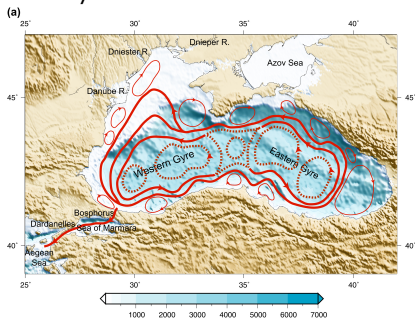


Spatial variability

Oxygen penetration depth



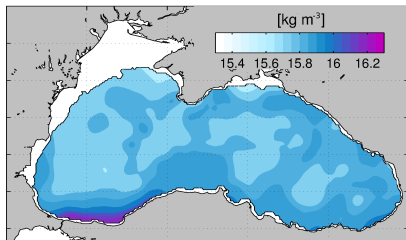
- ▶ Dome shape due to cyclonic circulation



Korotaev et al. 2003

Spatial variability

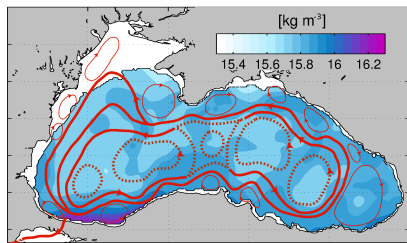
Oxygen penetration σ_θ



- ▶ Bosphorus plume oxygen injections
 - ▶ Advection of Bosphorus injections
 - ▶ Diapycnal mixing in the periphery
- Ostrovskii and Zatsepin, 2016, DSRI

Spatial variability

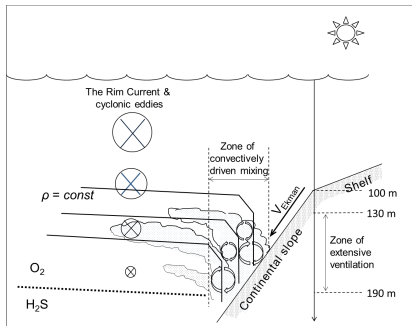
Oxygen penetration σ_θ



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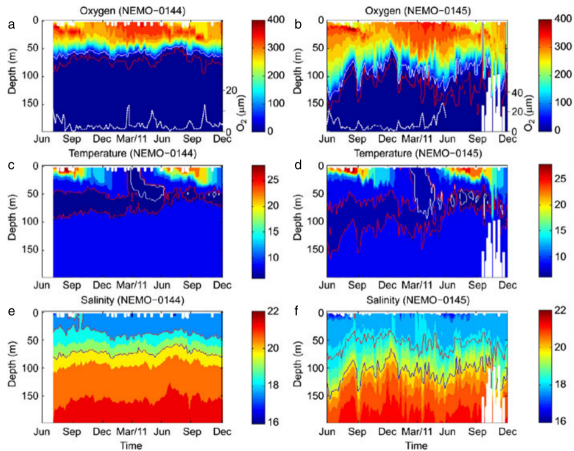
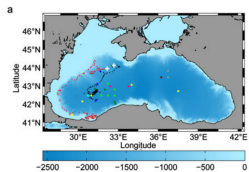
Spatial variability

Oxygen penetration σ_θ



- ▶ Bosphorus plume oxygen injections
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Ostrovskii and Zatsepin, 2016, DSRI

Diapycnal mixing in the open ?



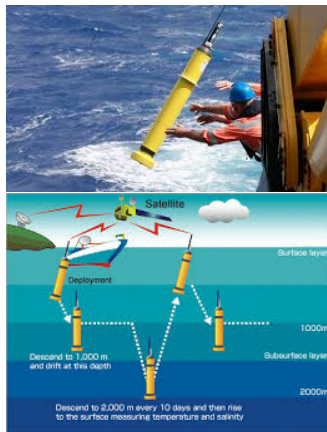
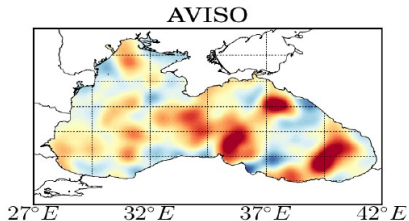
Stanev et al., 2013

Composite Analysis

Altimetry (Horizontal)

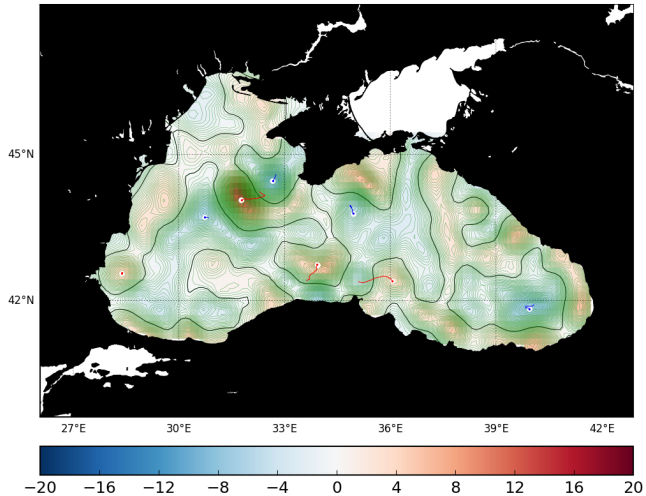
+

ARGO (Vertical)

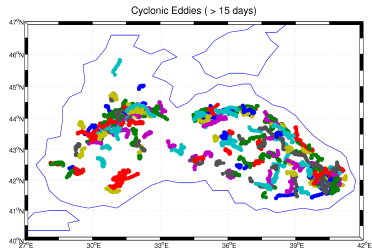
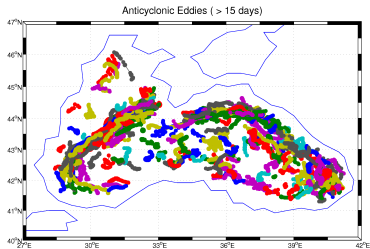


Altimetry : Eddy Tracking

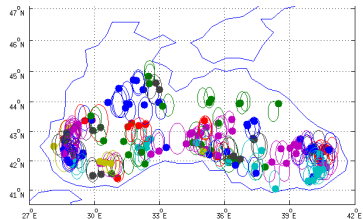
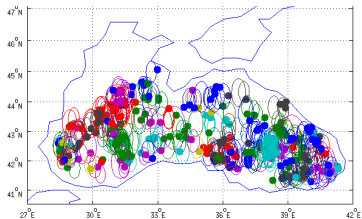
SLA 20050403



Altimetry : Eddy Tracking

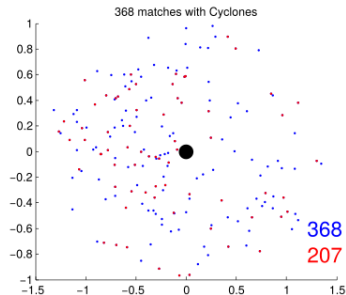
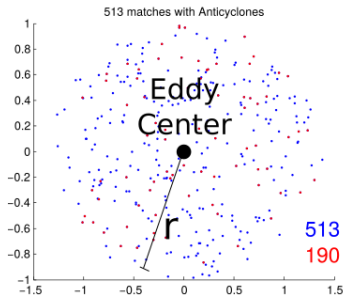


Matches (2005-2015)



Argo profiles within identified eddies.

Matches (2005-2015)

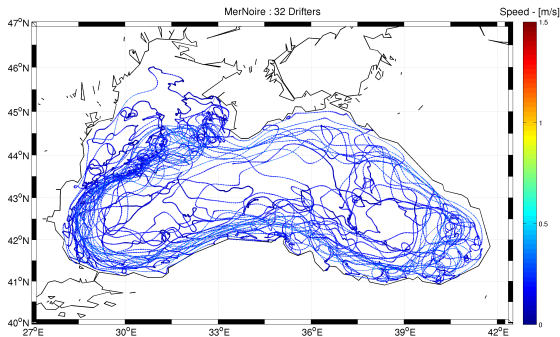


Blue: All ARGO Red: ARGO with Oxygen

→ Potential for investigation of mesoscale diapycnal mixing.

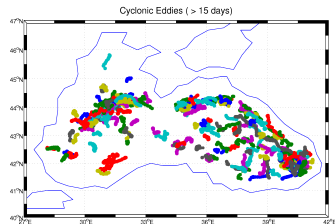
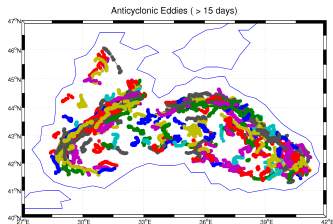
Coastal resolution ?

Lack of Eddies identification near the coast.
Potential improvement by regridding AVISO along-track data
(DIVA)



Coastal resolution ?

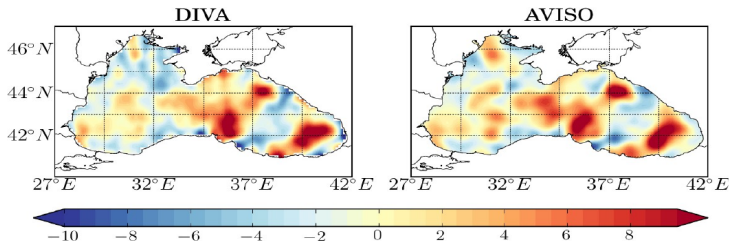
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Coastal resolution ?

Lack of Eddies identification near the coast.
Potential improvement by regridding AVISO along-track data
(DIVA)

2012-09-04

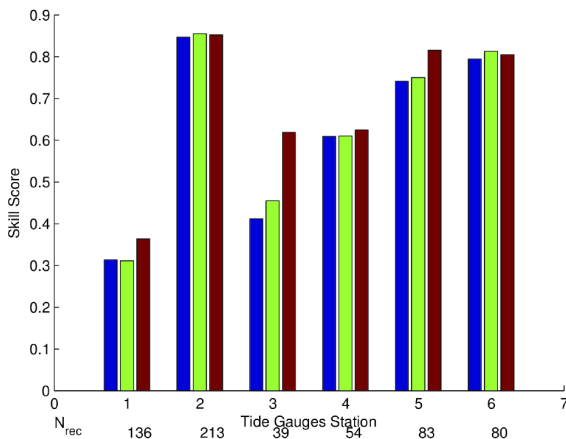


· *SLA interpolated fields obtained from DIVA and AVISO in the Black Sea for Sept. 9, 2012.*

Coastal resolution ?

Lack of Eddies identification near the coast.

Potential improvement by regridding AVISO along-track data (DIVA)



Slight improvement of Tide Gauge (PSMSL) validation
(AVISO2010 ; AVISO2014 ; DIVA)

Conclusions

- ▶ Quantifying ventilation processes needed to forecast the future trend of BS oxycline depth.
- ▶ Potential for composite analysis in the Black Sea (Altimetry + Argo)
- ▶ **Challenge** : Better resolution of coastal eddies (DIVA, Escudier et al. 2014, ...)

Thanks for your attention and questions

More info on :

Decline of the Black Sea oxygen inventory:

Capet et al, 2016, *Biogeosciences*

DIVA detrending algorithm:

Capet et al, 2014, *Ocean Dynamics*

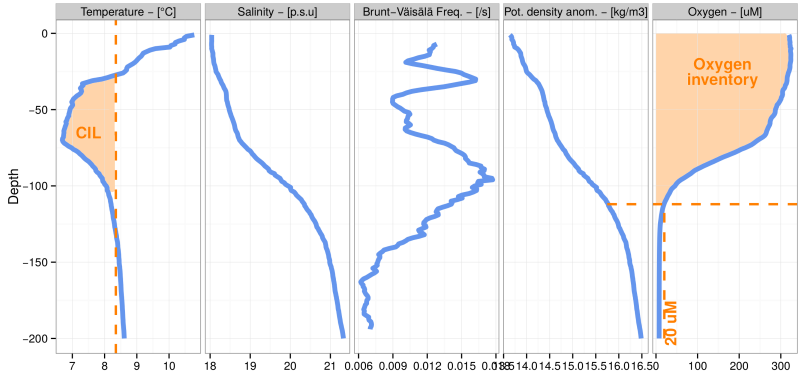
Ventilation along BS coasts :

Ostroovski and Zatsepin, 2016, *DSRI*

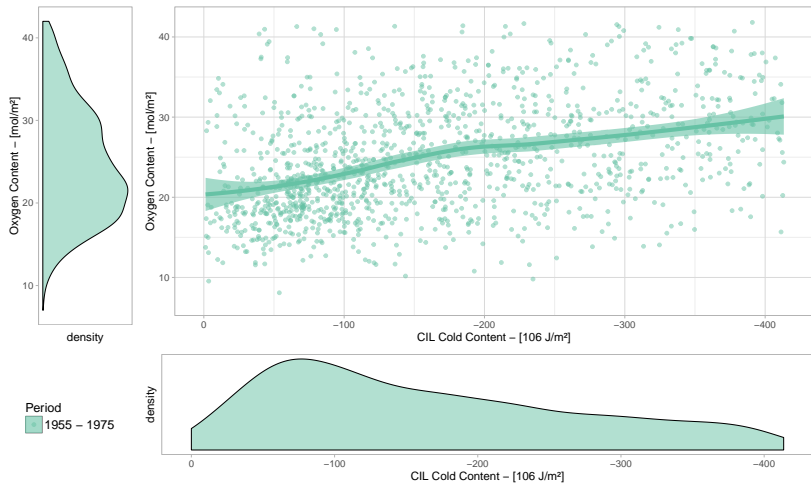
Python eddy tracker :

Mason et al, 2014, *DSRI*

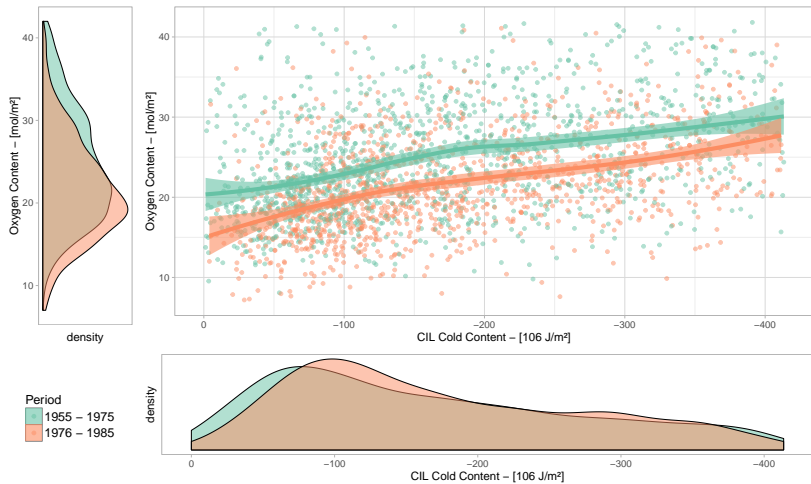
CIL ventilation



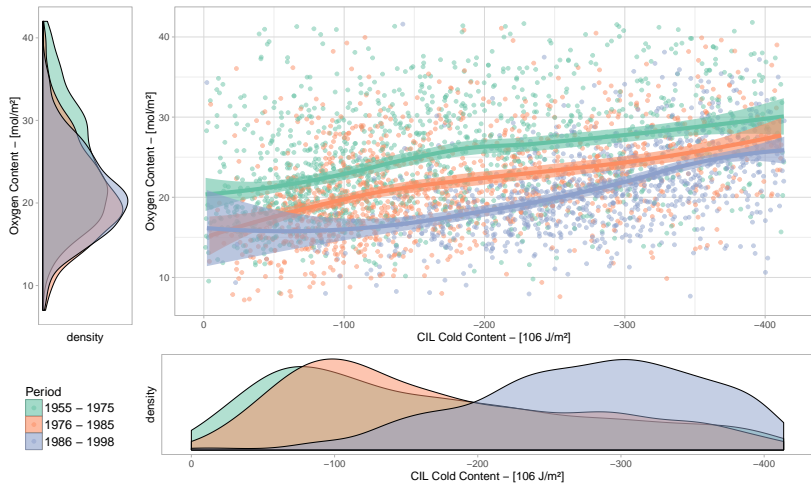
CIL ventilation



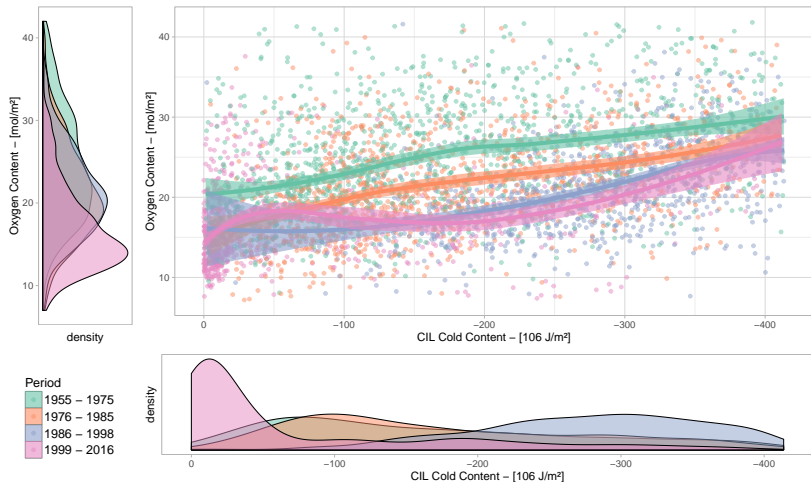
CIL ventilation



CIL ventilation



CIL ventilation



Eddy Stats + Distribution

