Potential for Composite Analysis in the Black Sea

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The Black Sea: Unique!
Vertical structure

Diagnostics of oxygen vertical structure

- Temperature – [°C]
- Salinity – [p.s.u]
- Brunt–Väisälä Freq. – [/s]
- Pot. density anom. – [kg/m³]
- Oxygen – [uM]
Vertical structure

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- Permanent Halocline

Diagnostics of oxygen vertical structure

▶ Oxygen penetration depth
▶ $\sigma_\theta$ at oxygen penetration depth
▶ Oxygen inventory
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Profiles Data

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

Data Interpolation Variational Analysis + detrending algorithm

Capet et al. 2014, Ocean Dynamics
Deoxygenation Trends: 1955 → 2015

Oxygen penetration depth

140 m → 90 m

Oxygen penetration $\sigma_\theta$

16.05 kg m$^{-3}$ → 15.4 kg m$^{-3}$

Oxygen inventory

-44%

Capet et al. 2016, Biogeoscience
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Oxygen inventory

Capet et al. 2016, Biogeoscience
Spatial variability

Oxygen penetration depth
Spatial variability

Oxygen penetration depth

Korotaev et al. 2003

Dome shape due to cyclonic circulation

Korotaev et al. 2003
Spatial variability

Oxygen penetration $\sigma_\theta$

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

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Spatial variability

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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

Contour map showing oceanographic data with isobaths and temperature gradients.
Altimetry: Eddy Tracking

Anticyclonic Eddies (> 15 days)

Cyclonic Eddies (> 15 days)
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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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

Period
- 1955 – 1975
- 1976 – 1985
Eddy Stats + Distribution