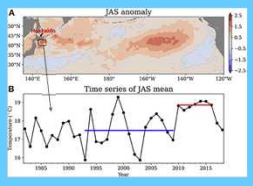
【S03-P2】Impact of the marine heatwave in the Oyashio region in 2022/23 on dissolved oxygen and subduction

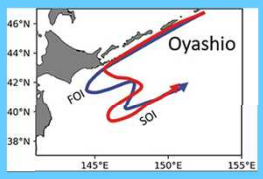
Yoshimi Kawai (JAMSTEC) ykawai@jamstec.go.jp

【Introduction】

The Oyashio region east of Japan has experienced frequent significant warming since 2010 (e.g. Miyama et al. 2021; Kawai et al. 2023).



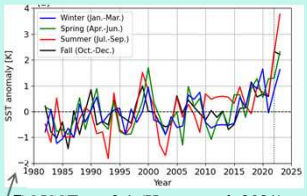
SST anomaly in summer (left) and schematic picture of the Oyashio when MHWs occurred (right)
(cited from Miyama et al. 2021)



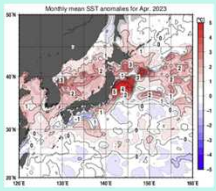
✓ MHWs occurred only in summer until 2014, but the Oyashio region warmed all the seasons from 2015.
✓ Anomalous warming ended in 2017, but resumed in 2019.

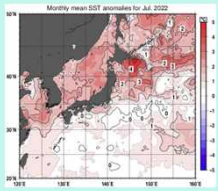
How does dissolved oxygen (DO) concentration respond to the recent MHW?

【MHW in 2022】

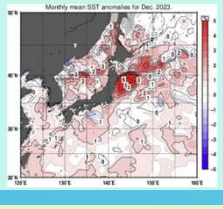


DOISST ver.2.1 (Huang et al. 2021) is used.





Japan Meteorological Agency's product



SST significantly increased from spring.

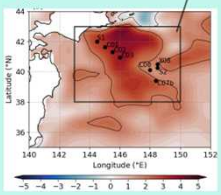
SST anomalies in summer and fall 2022 hit a record high as of this year. (Summertime SST in 2023 broke the record)

【In situ observations in 2022/23】

(1) R/V *Shinsei-maru* KS-22-10 cruise
15 July − 2 August 2022
CTD observations were conducted 12 times at 8 sites
temperature, salinity, chl-*a*, and DO

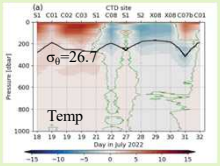
(2) Argo floats with DO sensor (BGC Argo floats)
WMOID: #2903654 February 2021 − February 2023

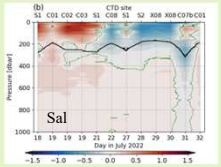
WMOID: #2903667 April 2022 − April 2023

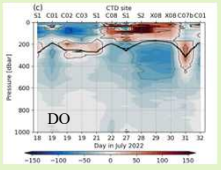


Anomalies from the WOA2018 climatologies are analyzes here

【R/V *Shinsei-maru* observation】

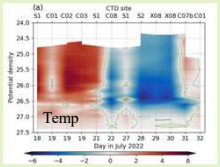


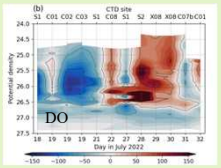




✓ DO anomaly has a negative correlation with T/S anomalies above 200 m, but not below it.

✓ In the density coordinates, DO and T anomalies are negatively correlated in $\sigma_\theta < 26.7$

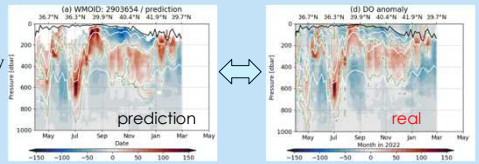




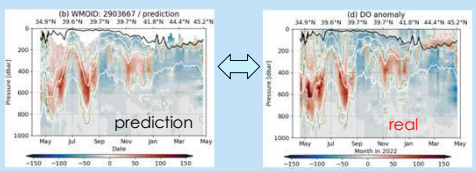
Correlation between DO and T anomalies in the density coordinate is strong. Is this relationship useful to estimate DO?

Make a regression formula to estimate DO anomaly from T anomaly in the density coordinate
↓
Estimate DO anomaly using this regression formula
↓
Add density-coordinate DO climatology and subtract pressure-coordinate DO anomaly

Estimation of #2903654 DO anomaly by the #2903667 regression formula

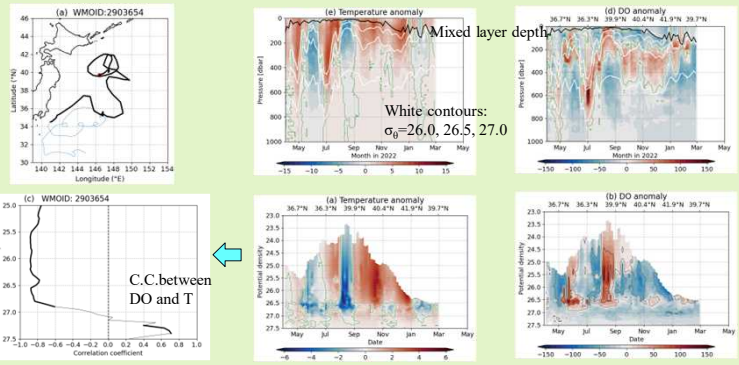


Estimation of #2903667 DO anomaly by the #2903654 regression formula

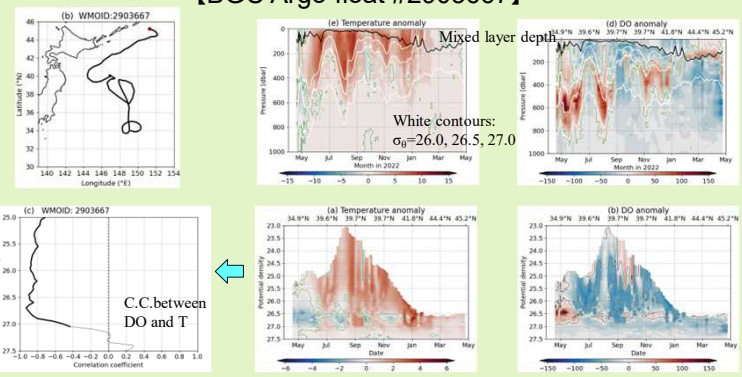


RMS error ≤ 30 μmol/kg

【BGC Argo float #2903654】



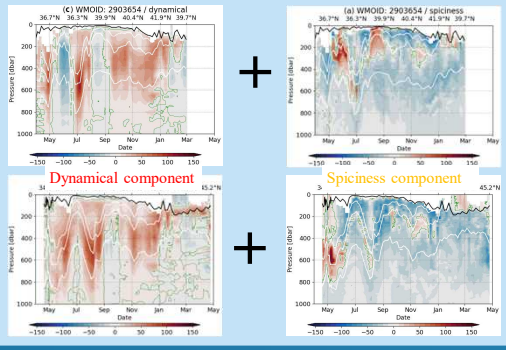
【BGC Argo float #2903667】



[Decomposition into spiciness and dynamical components]

$$O = \overline{O_p} + O'_p = \overline{O_d} + O'_d \Rightarrow \boxed{O'_p = (\overline{O_d} - \overline{O_p}) + O'_d}$$

Pressure coordinate — Density coordinate — Dynamical component — Spiciness component



Dynamical component
= density-surface heaving

Pushing down oxygen-rich water → oxygenation

Intrusion of the warm Kuroshio water

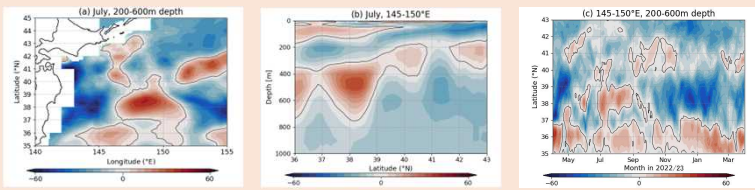
Spiciness component
= density-compensated

Isopycnal mixing → deoxygenation

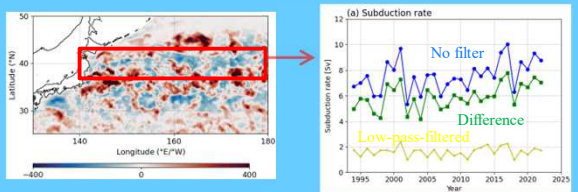
[Estimate spatial distribution of DO anomaly]

DO anomalies are estimated by the regression formula produced from the #2903654 data using eddy-resolving ocean reanalysis data.

JCOPE-FGO (Kido et al. 2022): 0.1°×0.1°, daily, 3DVAR



【Subduction rate】



Subduction rate anomaly in Nov. 2021–Oct. 2022

Subduction rate has been increasing despite the warming

Warm eddies contribute to the enhancement of subduction

Does this affect BGC processes?

Kawai, Y., E. Oka, K. Sato, S. Hosoda and S. Kido (2025), *J. Oceanogr.* doi:10.1007/s10872-024-00731-x