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Nutrient distribution around the Bussol' Strait

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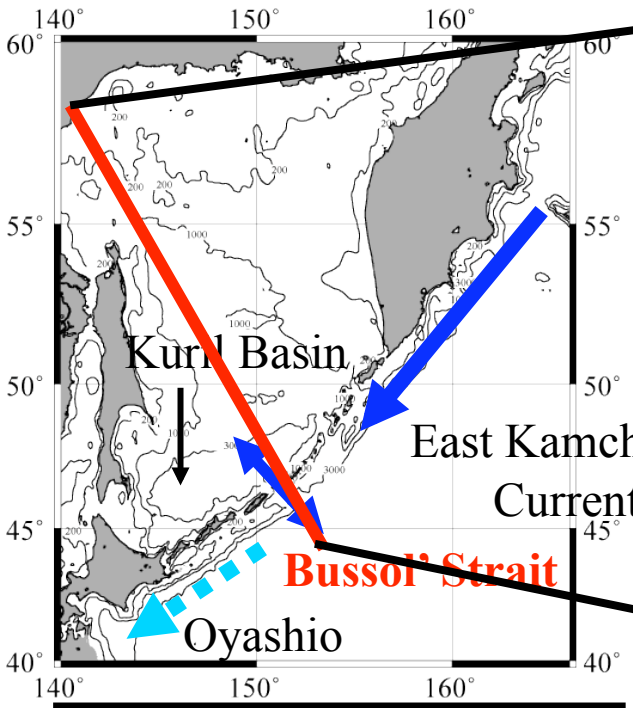
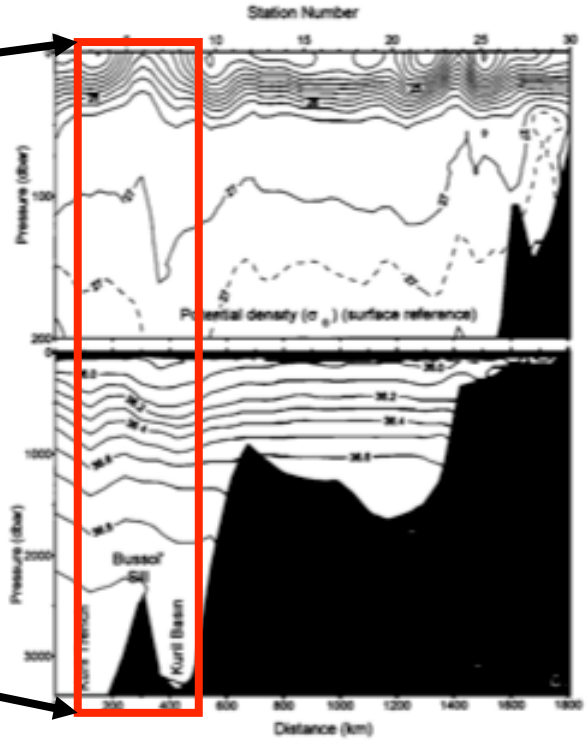
Introduction



Schematic diagram of current around Bussol' Strait

Relatively homogeneous water exists



0-200m

0-3000m

Density distribution of WOCE p1w line crossing Bussol' Strait (Fleeland *et al*., 1997)

- Intensive water exchange between North Pacific and the Sea of Okhostk, and consequent modification and formation of characteristic water masses (Fleeland *et al*, 1998, etc…)
- Distributions of temperature and dissolved oxygen may be affected by vertical mixing around 27.3-27.6σ_θ (Ono *et al*., 2007)

The problem is…

Nutrients distribution around the Bussol' Strait and effect of vertical mixing are not necessary clear, because of…

+ Lack of detailed observations of nutrients
+ Absence of direct measurements of vertical mixing

Thus,

The purpose of this study:
+ To describe nutrients distribution around the Bussol' Strait
+ To clarify effects of vertical mixing on the distributions of nutrients

+ Perform intensive observations on nutrient distribution and vertical mixing
+ Compare the observed data with historical data

Observation

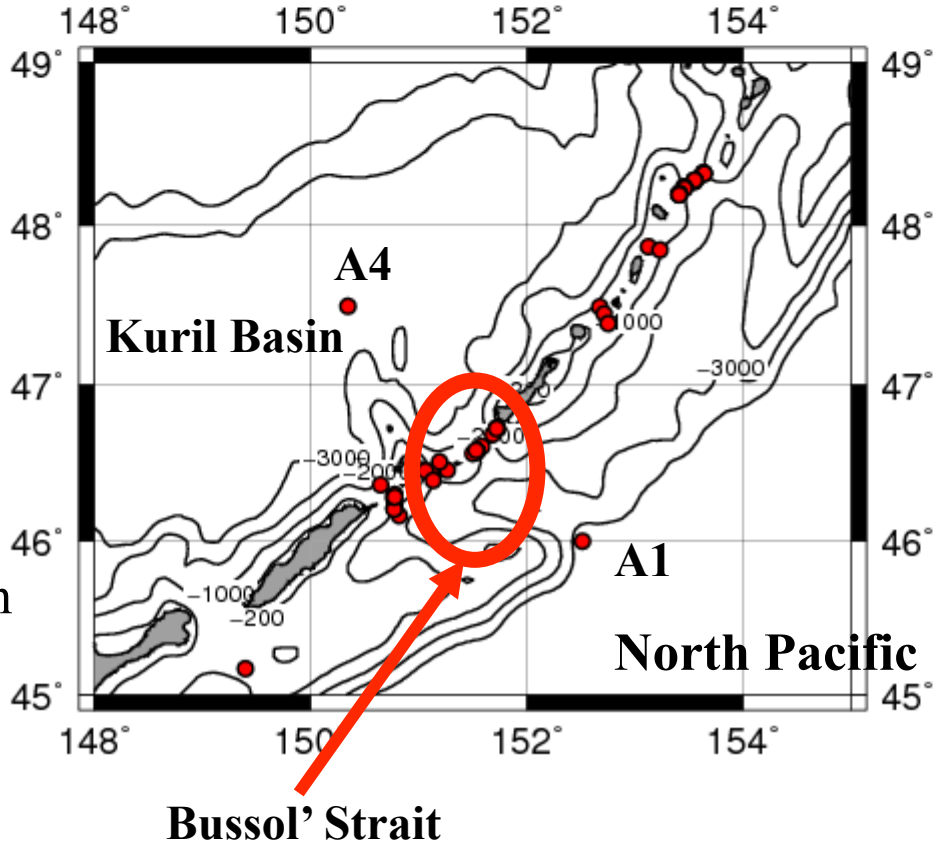
Summary of Kh07 Cruise

Period : 9 Aug. - 12 Sep. 2007

R/V Prof. Khromov

71 stations around the Kuril Islands including 3 times near one-day (~24hr) observations in the Bussol' Strait

- Hydrographic data (CTD-CMS)
  Temperature, salinity, dissolved oxygen
  nutrients (phosphate, nitrate)
- Vertical diffusivity (VMP500 / 2000)



Nutrients sample were preserved by freezing once and analyzed with auto-analyzer (AACS)

Source water obtained from historical data

there are two major sources of the water around the Bussol' Strait (Ono *et al.*, 2007)

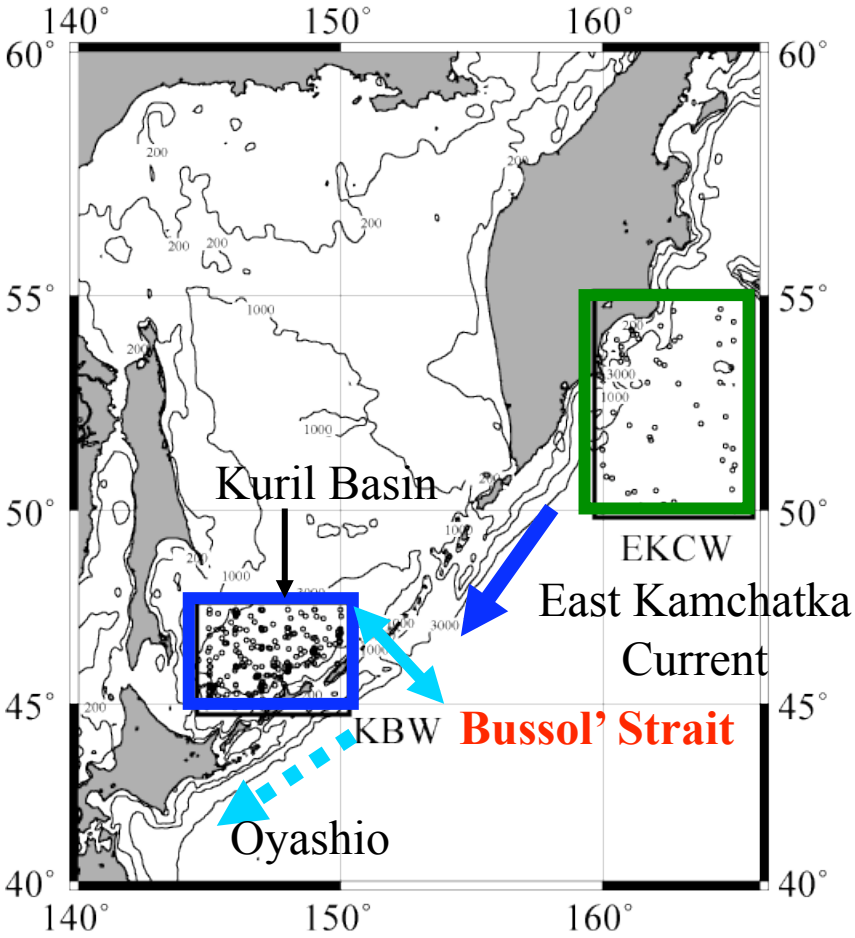
North Pacific

EKCW : East Kamchatka Current Water

The Sea of Okhostk

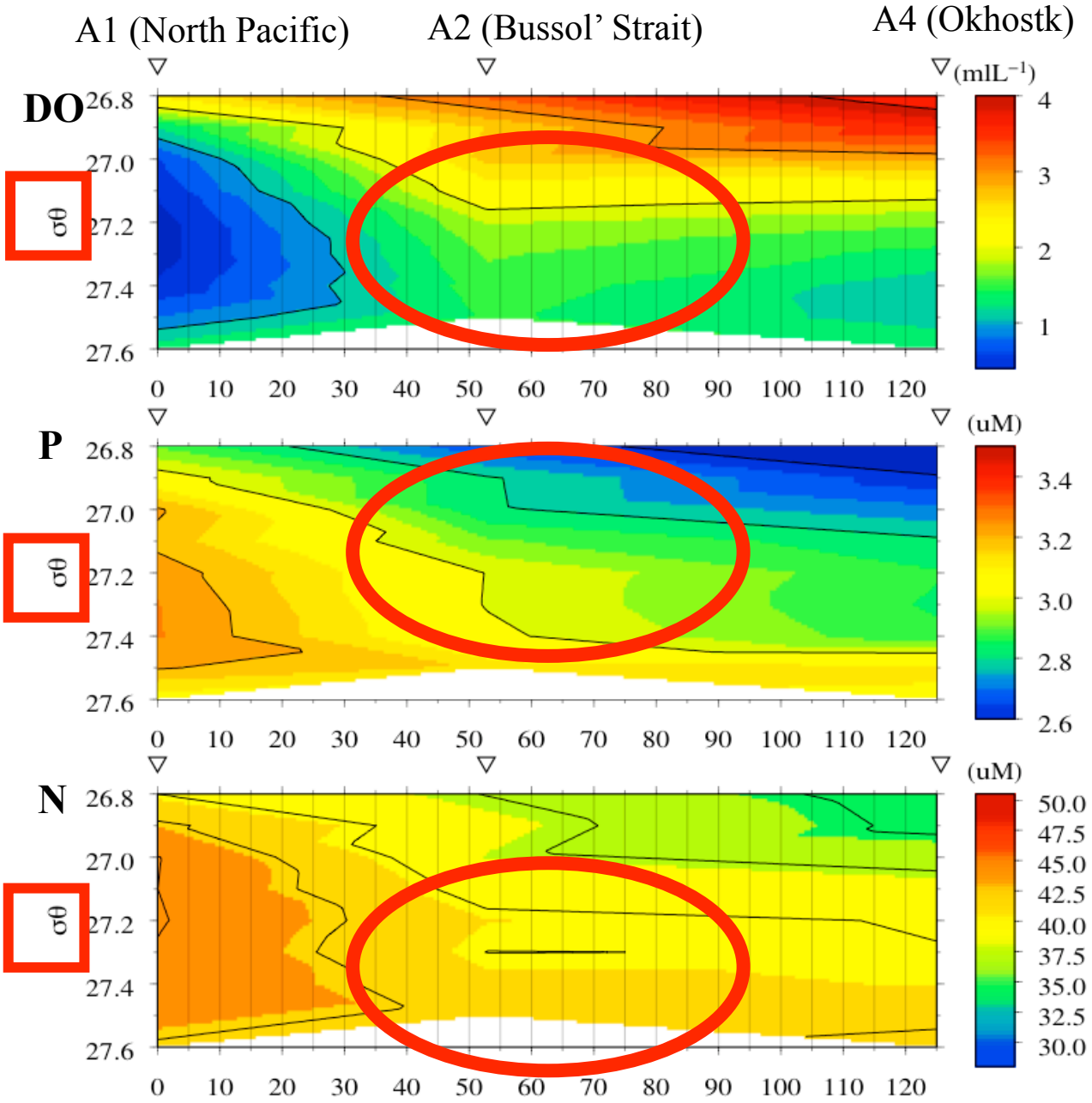
KBW : Kuril Basin Water

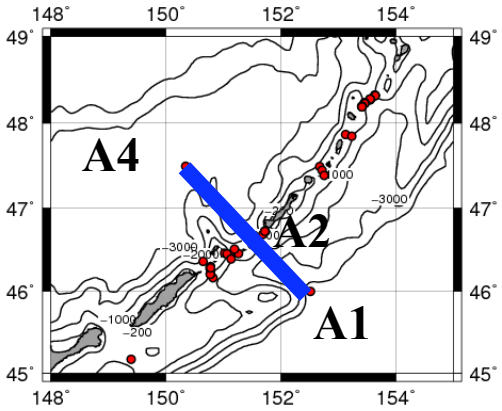
WOD'05 (World Ocean Database 2005) were used in order to figure out typical source water mass of the water in the Bussol' Strait



Definition of two regions of source waters of the water in the Bussol' Strait

Vertical section of A-line





DO : NP < Ok

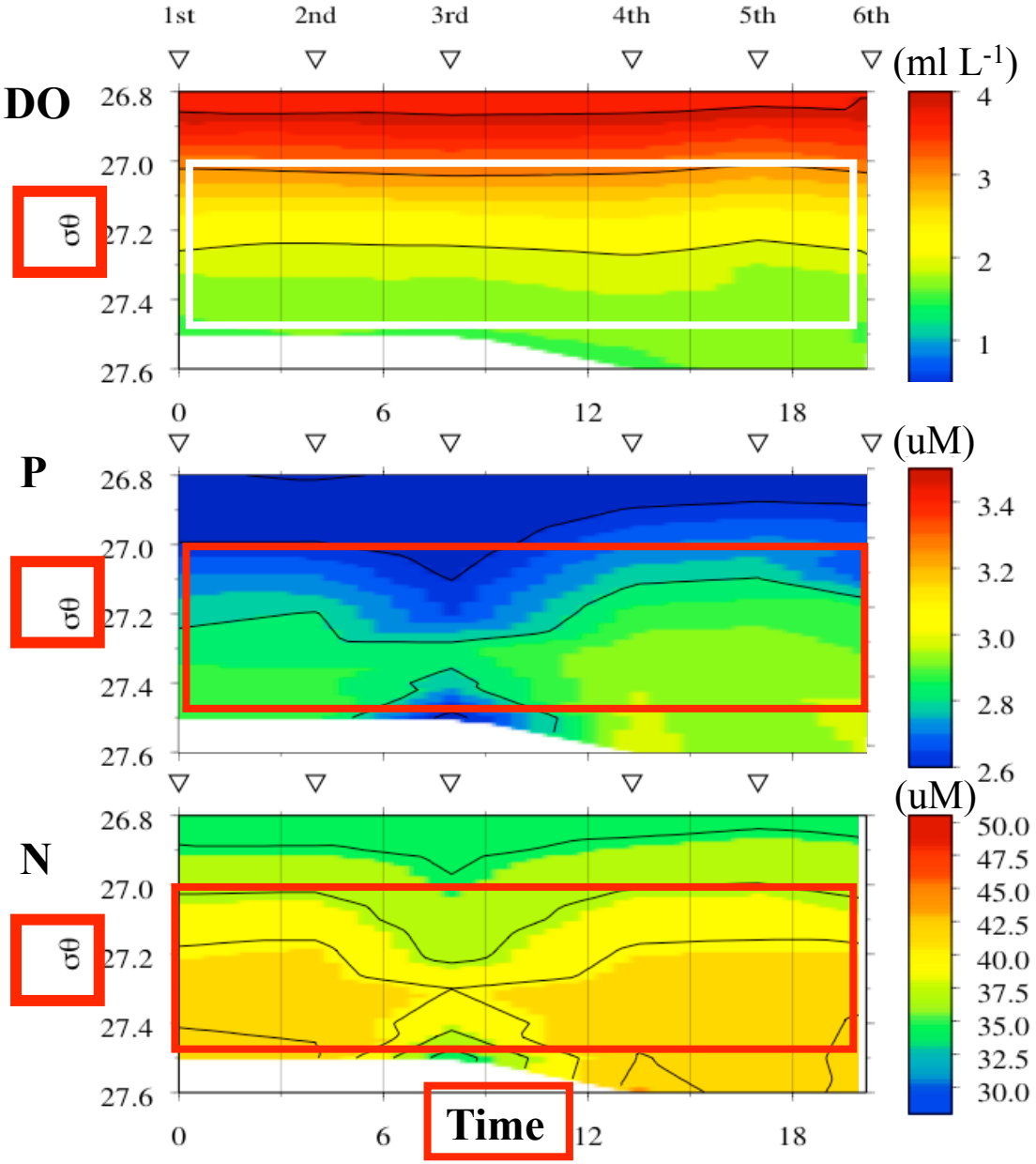
P, N: NP > Ok

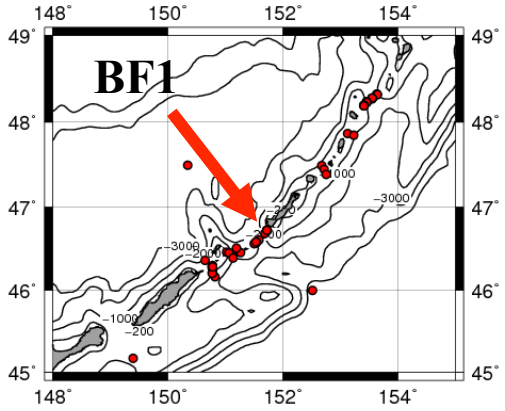
NP: Noth Pacific

Ok: Okhotsk

Around the Bussol' Strait, profiles are vertically relatively homogeneous (Consistent with the result of WOCE p1w observation)

Near one-day observation (St. BF1)





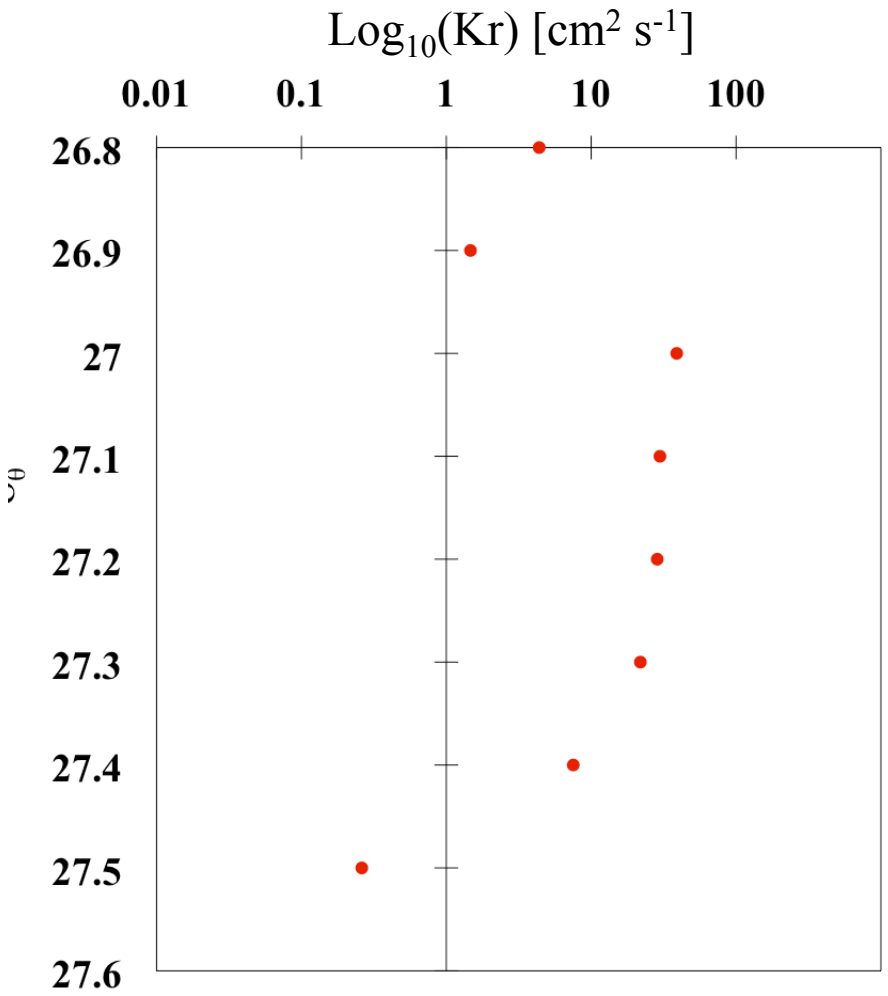
$27.0 \sim 27.4\sigma_\theta$

large variability with diurnal tendency

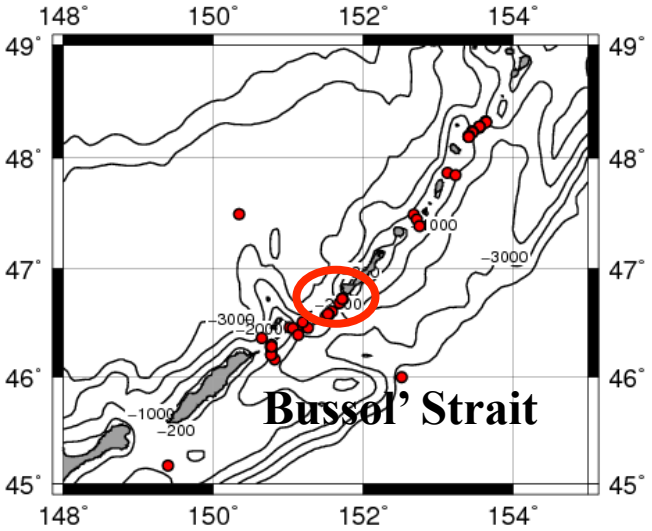
Lateral water exchange with K1 tide (diurnal) and/or consequent vertical mixing

How about vertical mixing intensity ?

Vertical diffusivity profile



Vertical diffusivity profile in the Bussol' Strait in density coordinate (21 stations average)



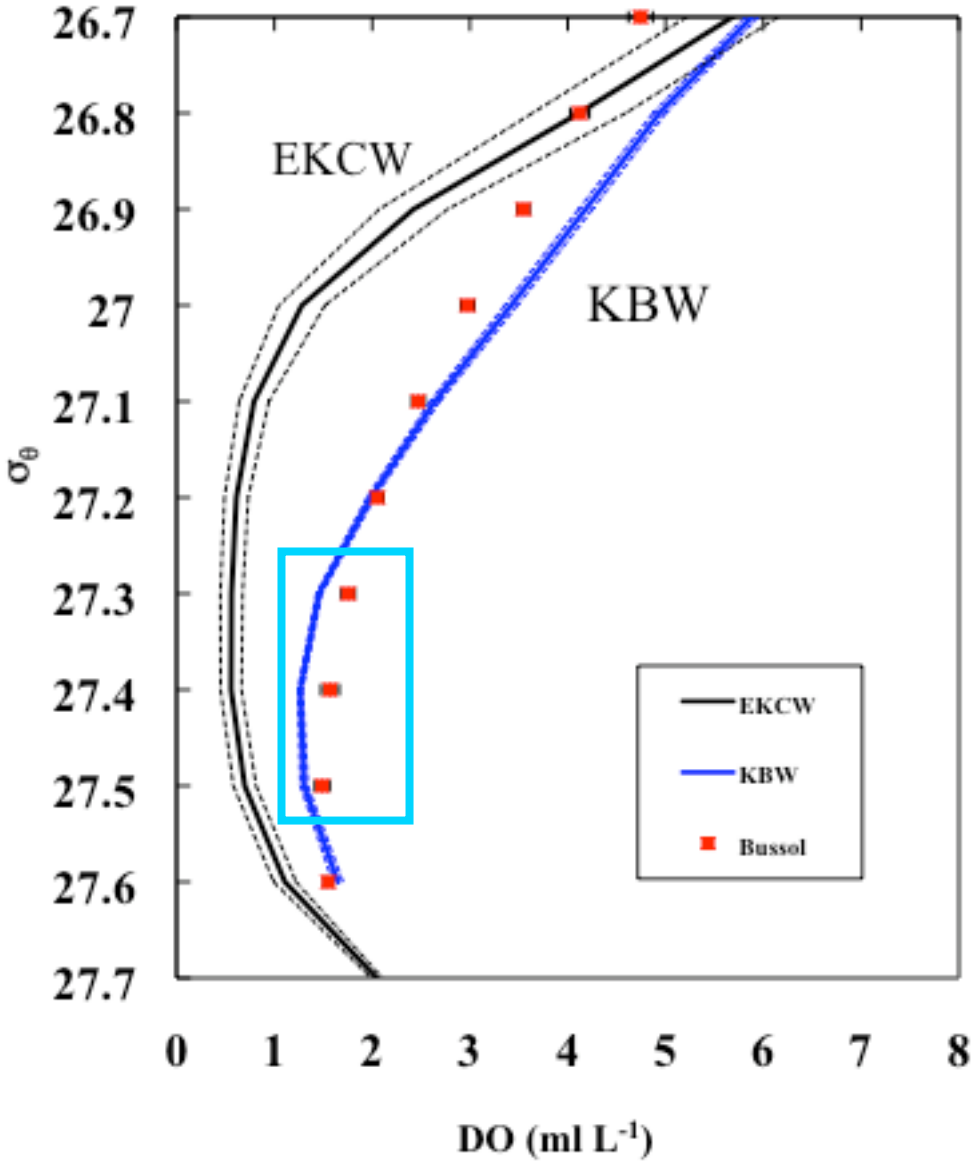
$27.0 \sim 27.4\sigma_\theta$

Kr : 10～100 [$cm^2 s^{-1}$]

Typical value of Kr on oceanic thermocline : ~0.1 [$cm^2 s^{-1}$] (Gregg, 1987)

This strong vertical mixing might affect on vertical distribution of dissolved oxygen, nutrients, etc…
compare with source waters obtained historical data to consider an effect of vertical mixing

Vertical distribution of dissolved oxygen (DO)



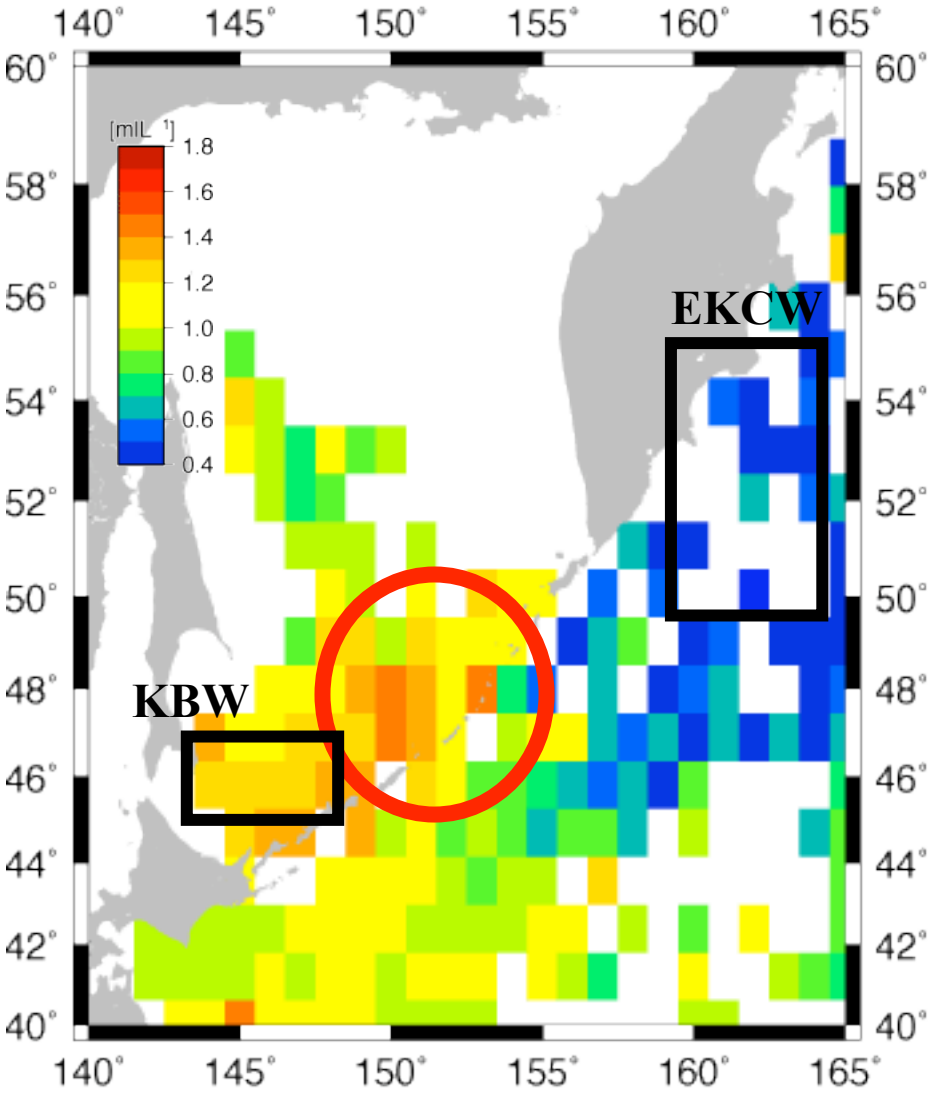
EKCW & KBW : DO_{min} ~ 27.4 σ_θ
27.3 - 27.5σ_θ : Bussol is greater than source waters

This cannot be explained by isopycnal mixing between EKCW and KBW alone.
But it is consistent with the idea that…

Relatively high DO water around 27.4 σ_θ in the strait is formed by intensive mixing with DO rich waters above and below and vertical mixing makes vertical DO_{min} structure weak.

How about horizontal distribution ?

Horizontal isopycnal distribution of DO at $27.4\sigma_\theta$



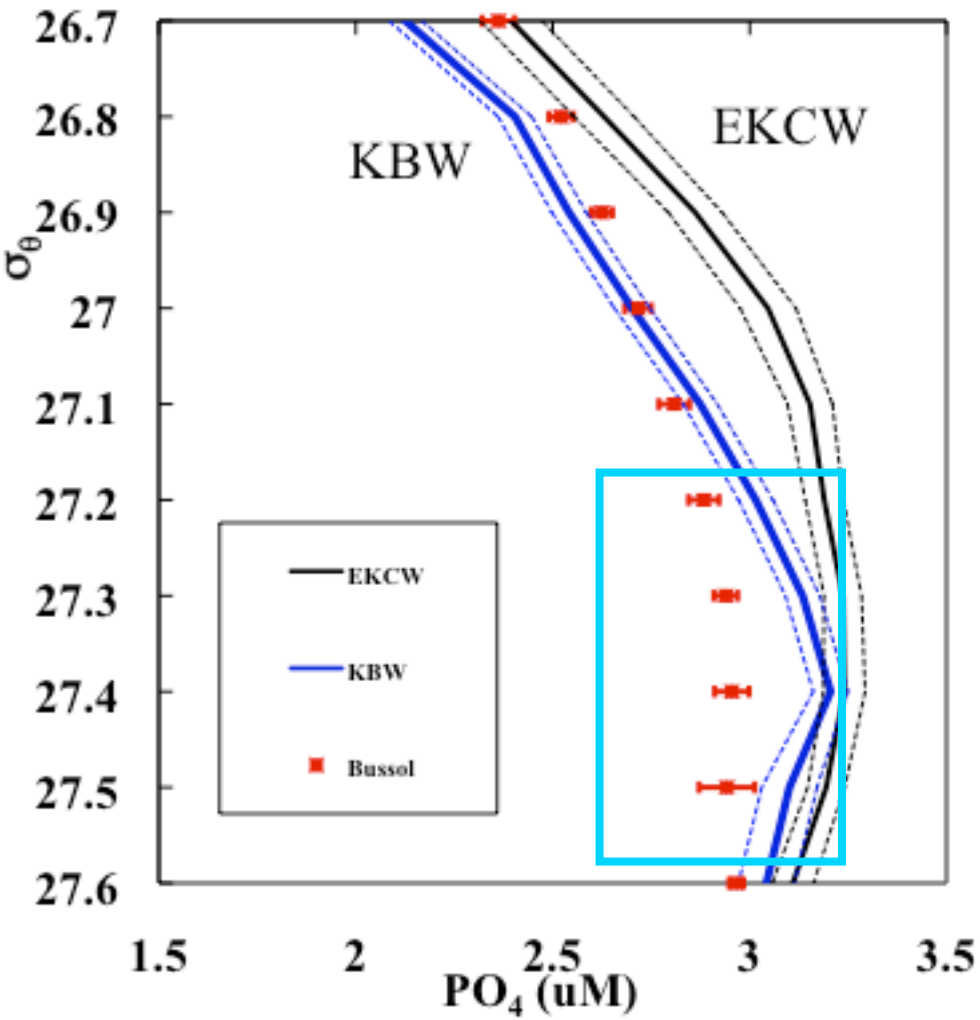
WOD'05 + Kh07
Each 1° x 1° sub-grid

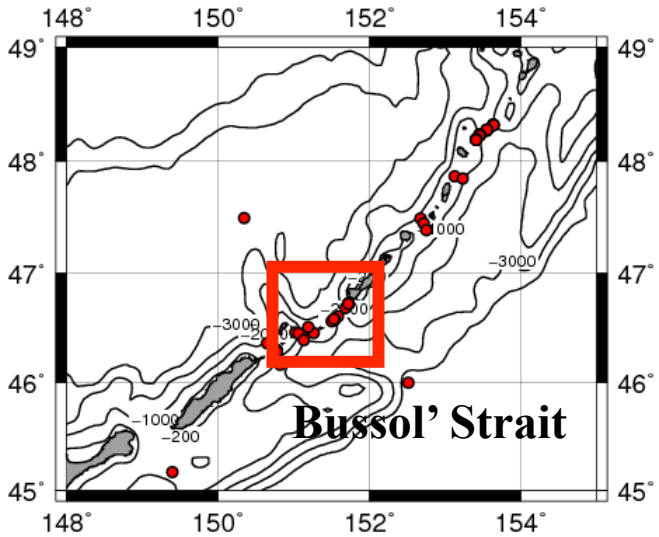
- EKCW：low (~0.4ml L^{-1})
- KBW：relatively high (~1.2ml L^{-1})
- Bussol' Strait : high (1.4ml L^{-1})

DO rich water distributes not only vertically but also horizontally around the Bussol' Strait

How about nutrients distribution ?

Vertical distribution of Phosphate





EKCW & KBW :

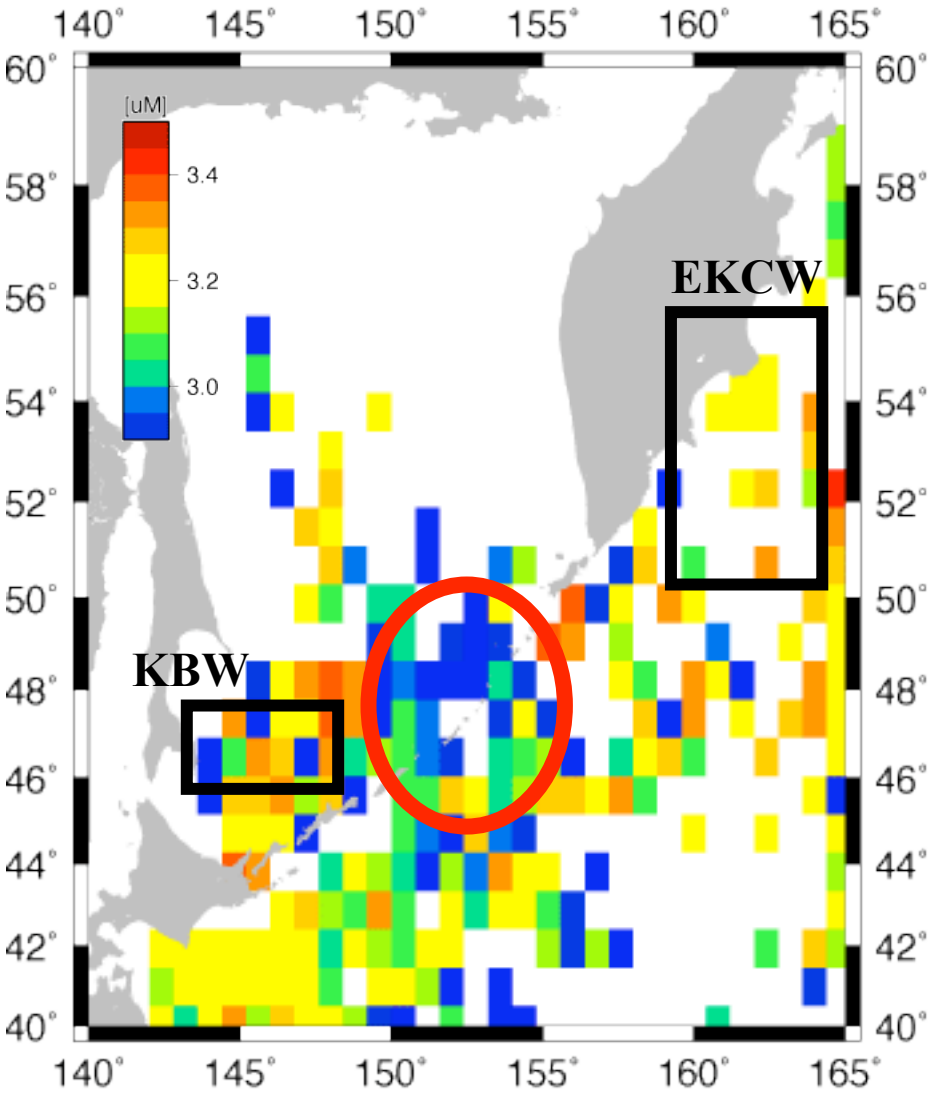
vertical-P_{max} ~ 27.4 σ_θ

27.2 - 27.5σ_θ : Bussol' is lower

Vertical mixing in the strait may weaken P_{max} and form the lower concentration of phosphate than both of EKCW and KBW in 27.2 – 27.5σ_θ.

(Nitrate distribution is consistent with this)

Horizontal distribution of Phosphate at $27.4\sigma_\theta$



EKCW: High (~ 3.2 [uM])
KBW: High (~ 3.3 [uM])
Around the Bussol' Strait :
relatively lower
(less than 3.1 [uM])

Consistent with DO distribution

Vertical mixing in the Bussol' Strait might affect on phosphate distribution around the Strait both vertically and horizontally

Summary

Nutrient distributions around Bussol'Strait are shown and their characteristics are analyzed with historical data

- Relatively homogeneous vertical profiles and large diurnal variability (DO, Nitrate, Phosphate)
- Existence of strong vertical mixing in 27.0 - 27.4σ_θ (Kr ~ O(10^0 - 10^3) [cm^2s^{-1}])
- lower (higher) concentration of phosphate (DO) in 27.2 - 27.5σ_θ than both of the source waters of EKCW and KBW in the strait
- horizontal lower (higher) phosphate (DO) distribution at 27.4σ_θ around the strait

Vertical mixing can significantly weaken vertical maximum (minimum) and change nutrients (DO) distributions in/around the Bussol' Strait