# Coupling ROMS and BEC: Application to the North Pacific

It is still under construction.

**Misumi, K.**, Tsubono, T., Tsumune, D. and Yoshida, Y.
Central Research Institute of Electric Power Industry

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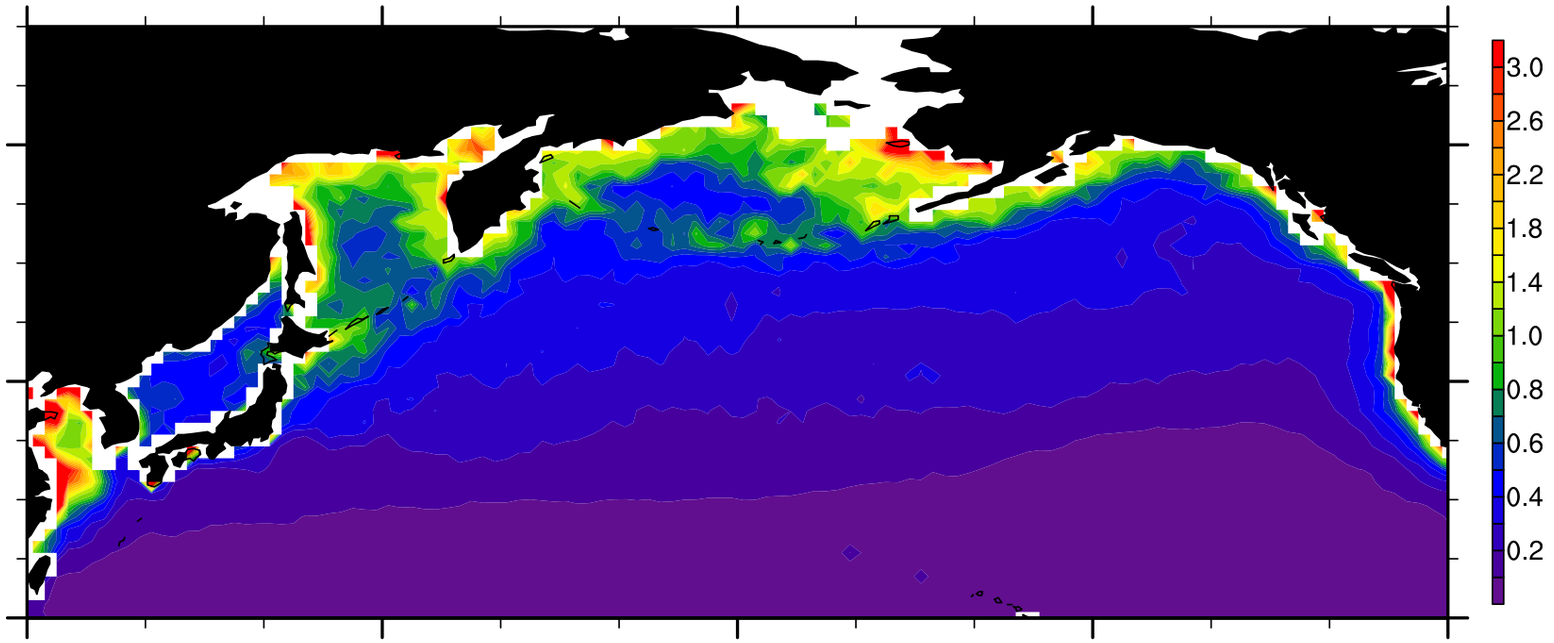
**Chl a** (ug/L)
by AQUA/MODIS



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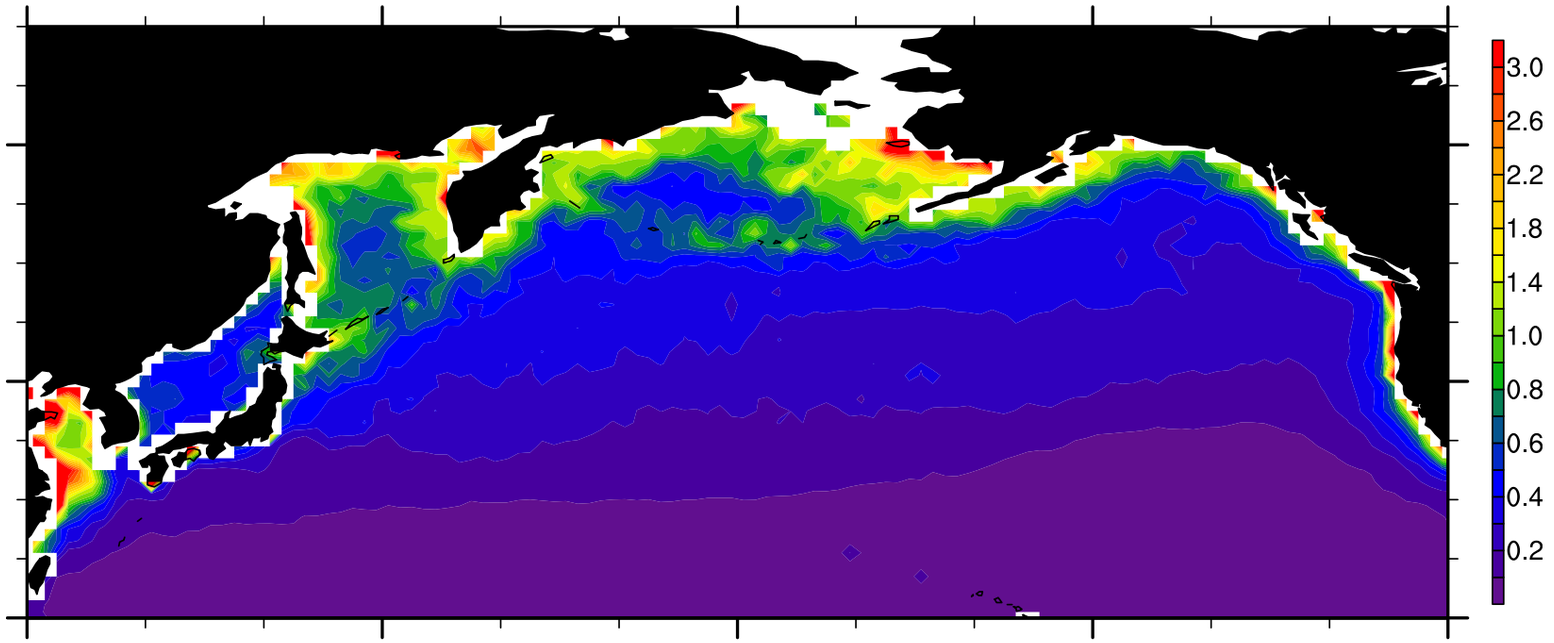
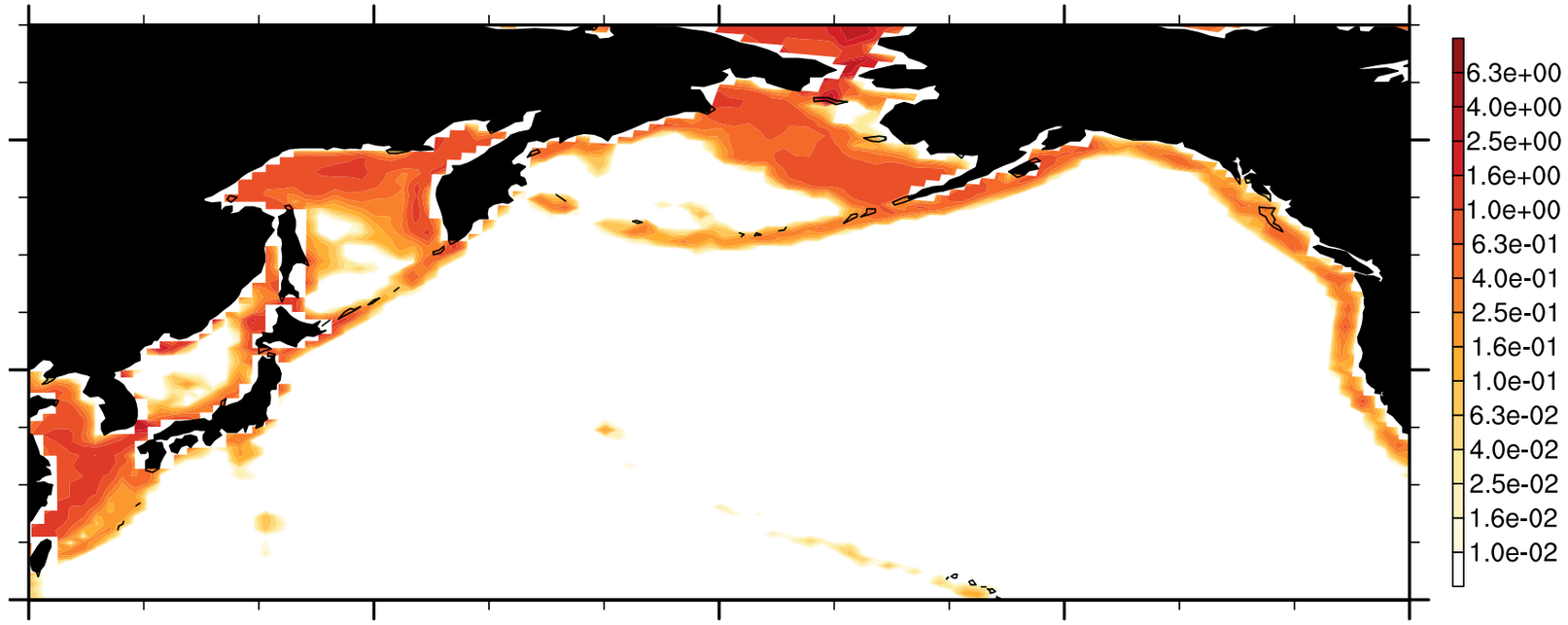
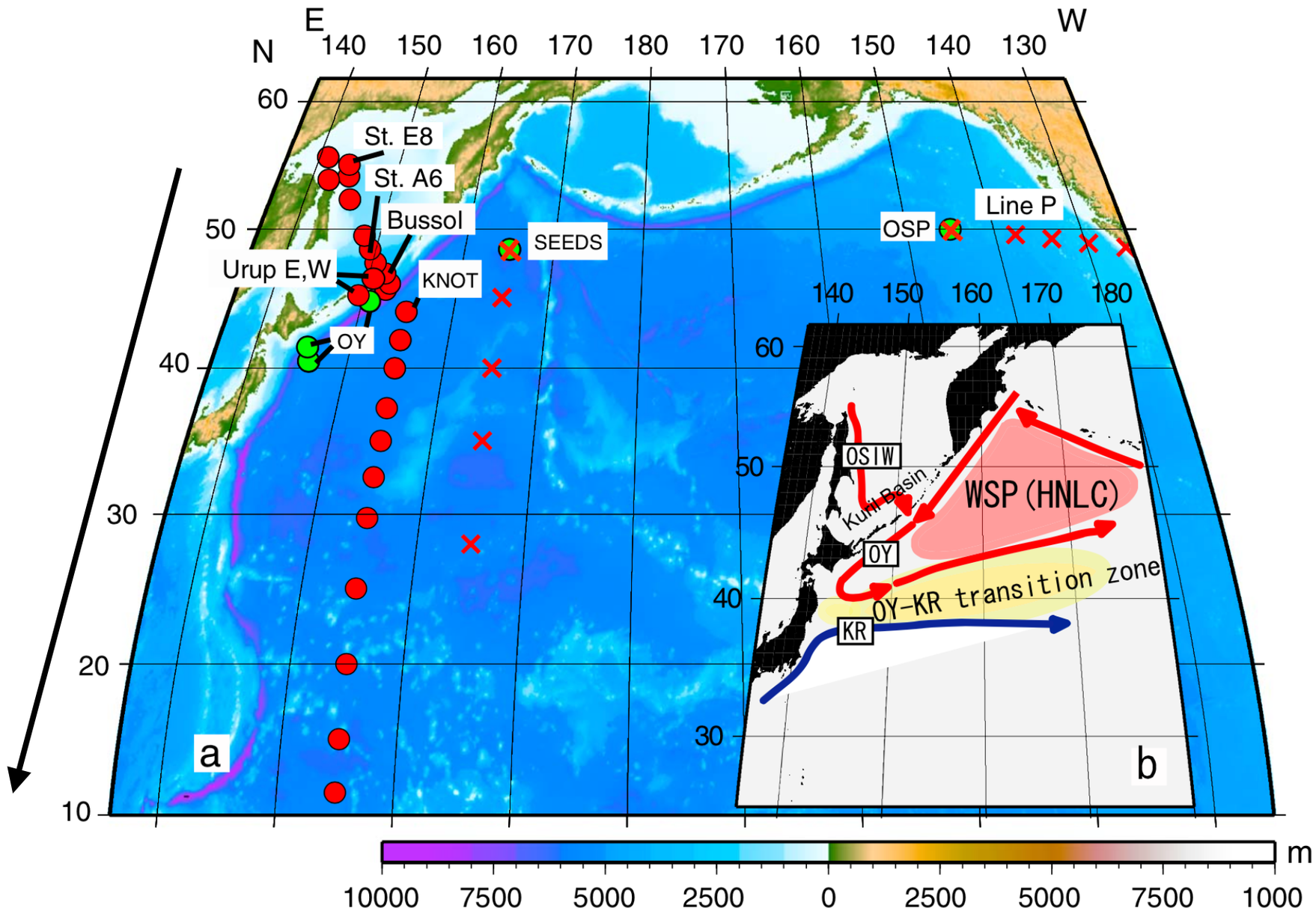
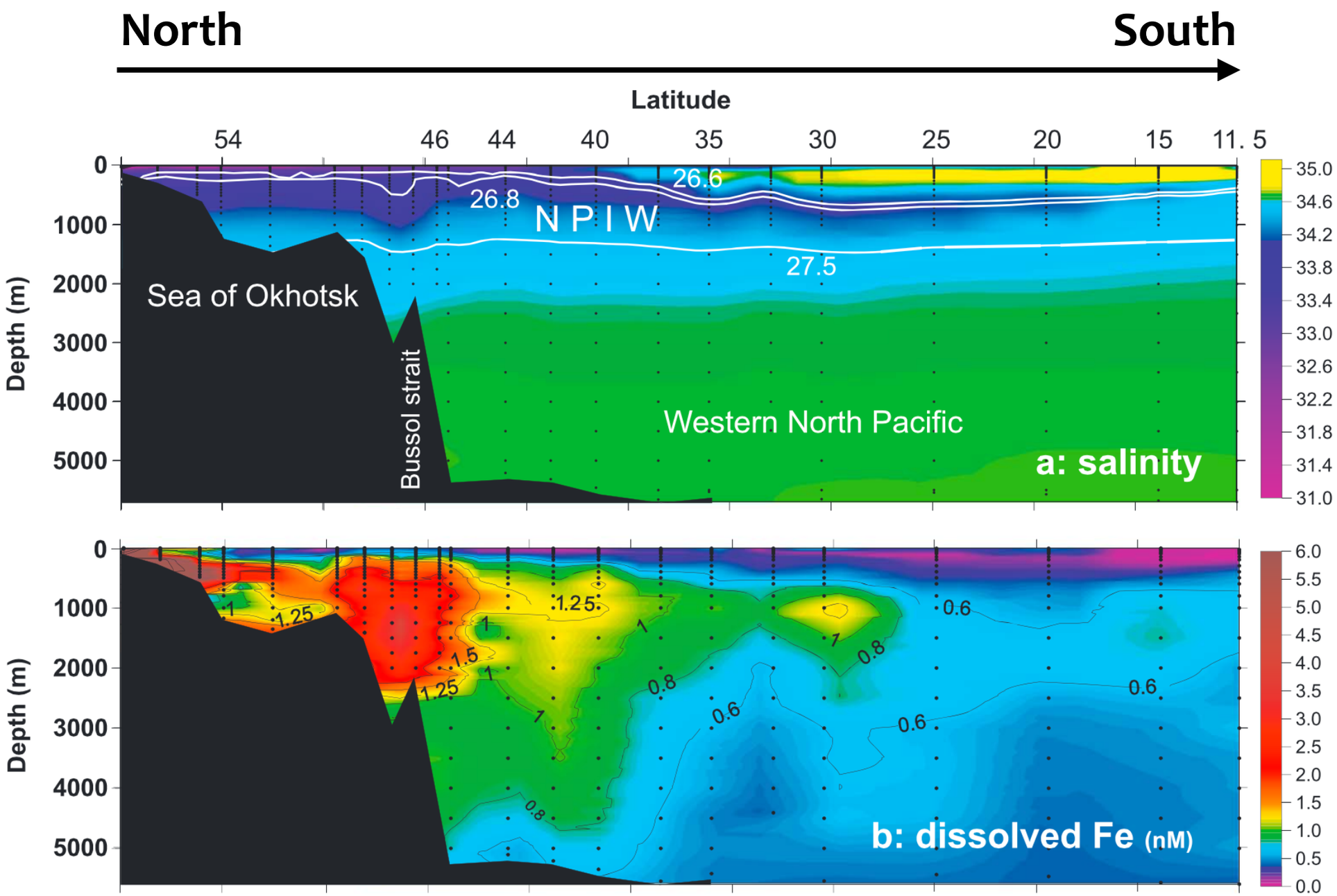



**Sedimentary iron flux**
(mmol/m²/yr)
Moore & Braucher (2008)



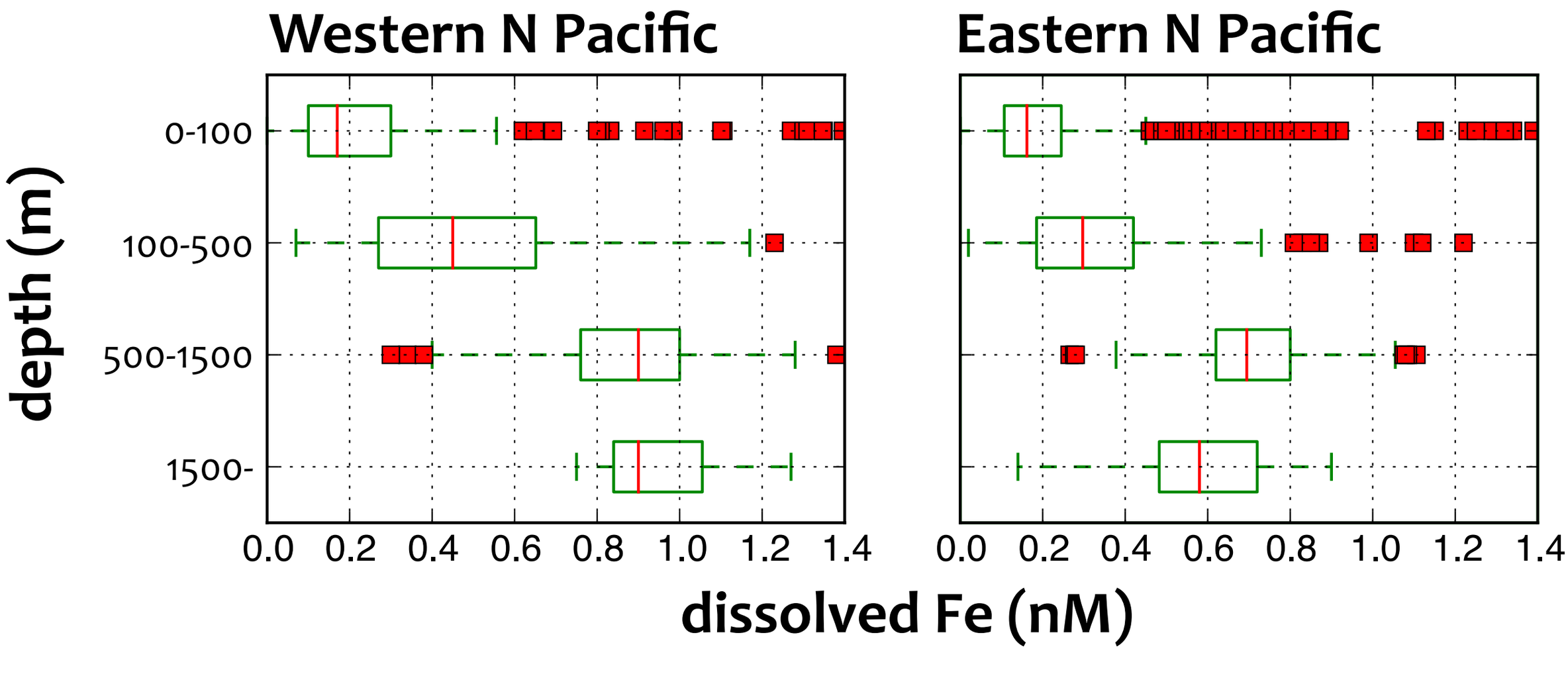



Nishioka et al. (2013)



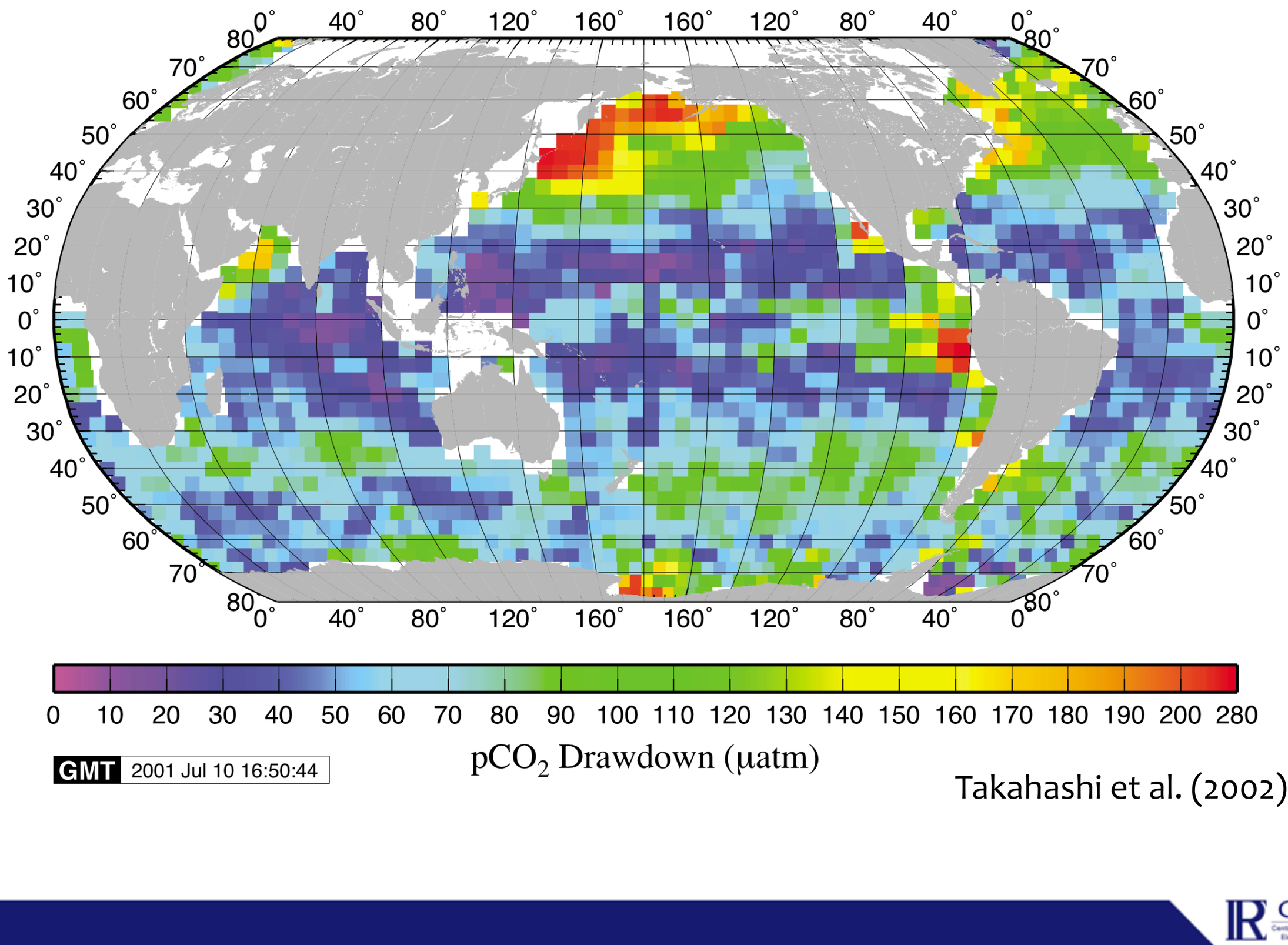

Nishioka et al. (2013)

# Dissolved iron concentrations in the North Pacific




Compiled data by Tagliabue et al. (2012)

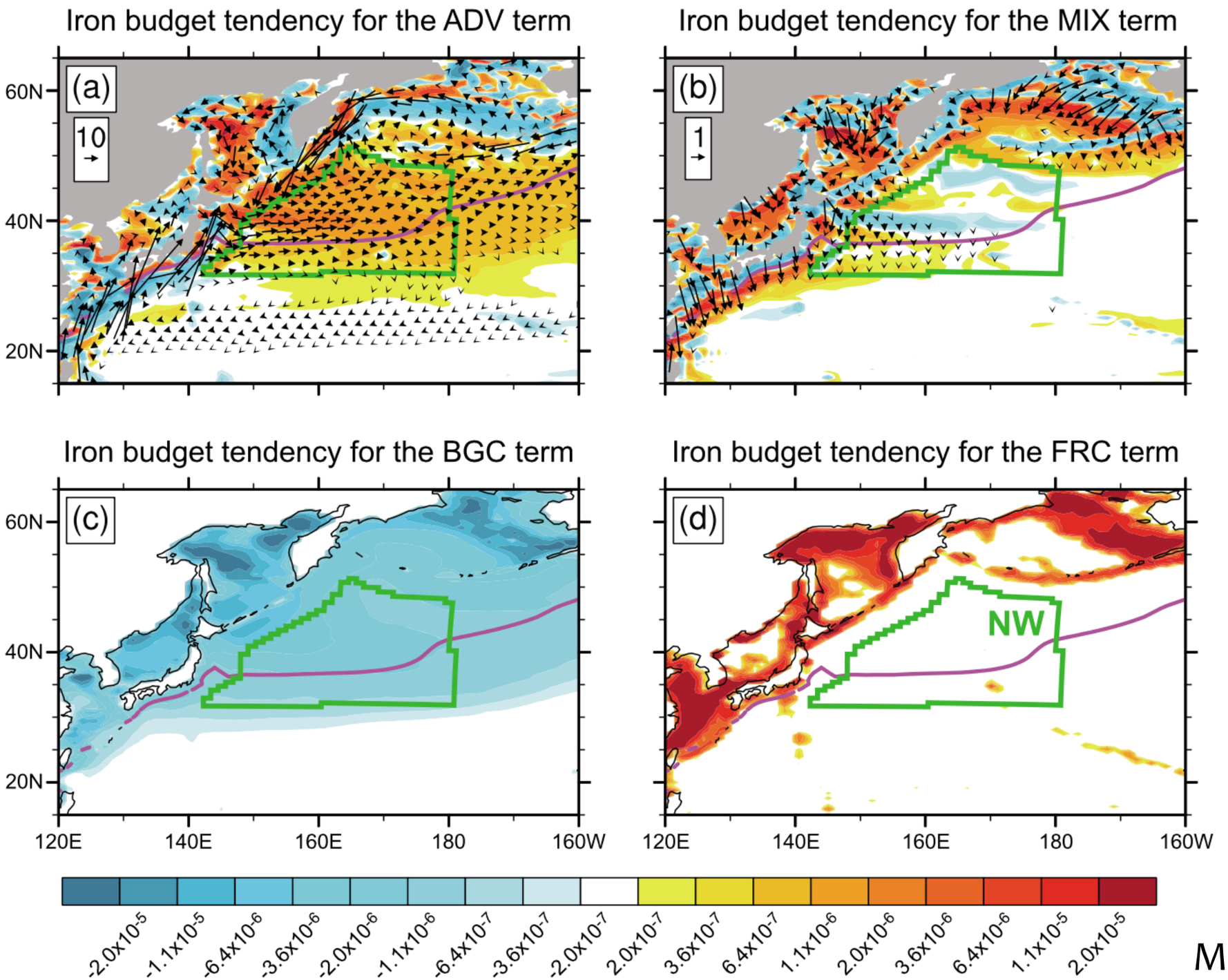
# Seasonal Biological Drawdown of Seawater $pCO_2$




$pCO_2$ Drawdown (μatm)

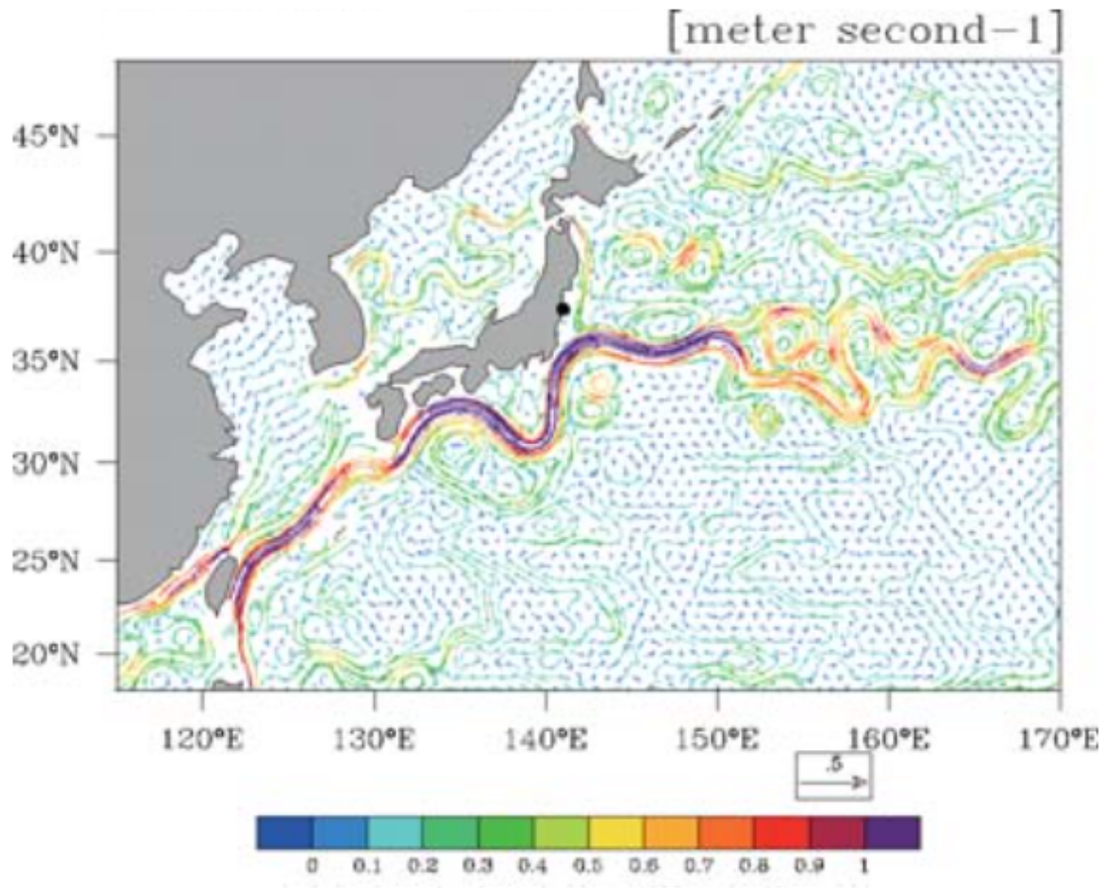
Takahashi et al. (2002)

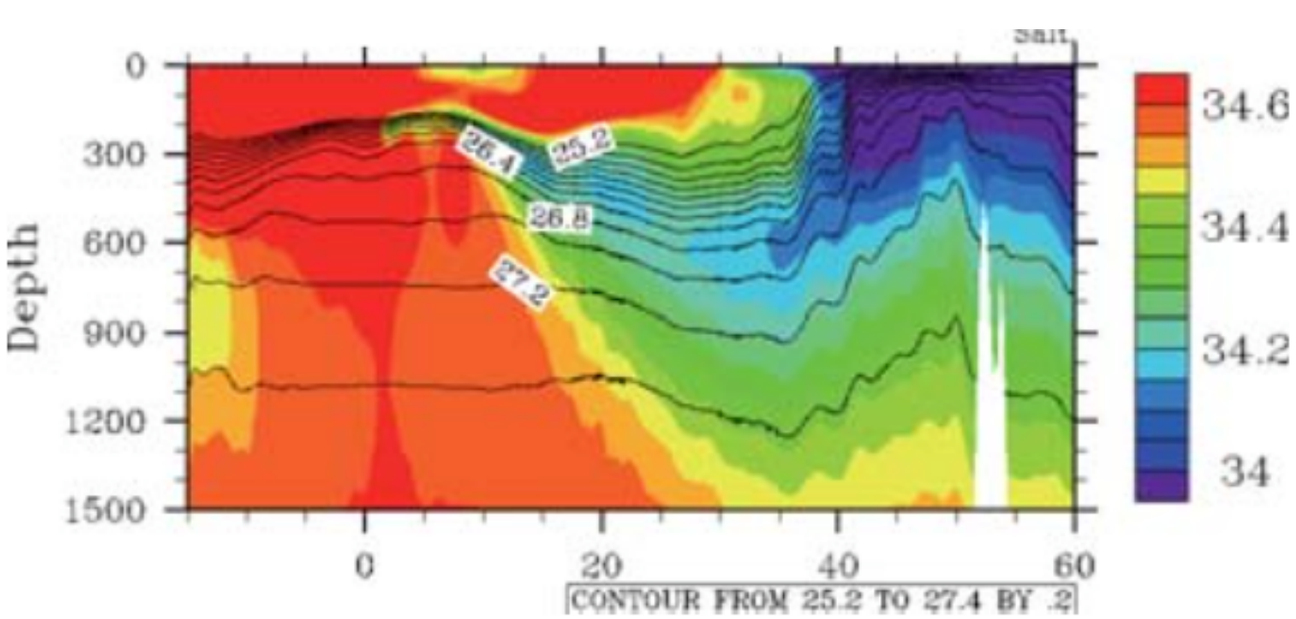
# We investigated the iron transport process using **POP+BEC (1deg)**




Misumi et al. (2011)

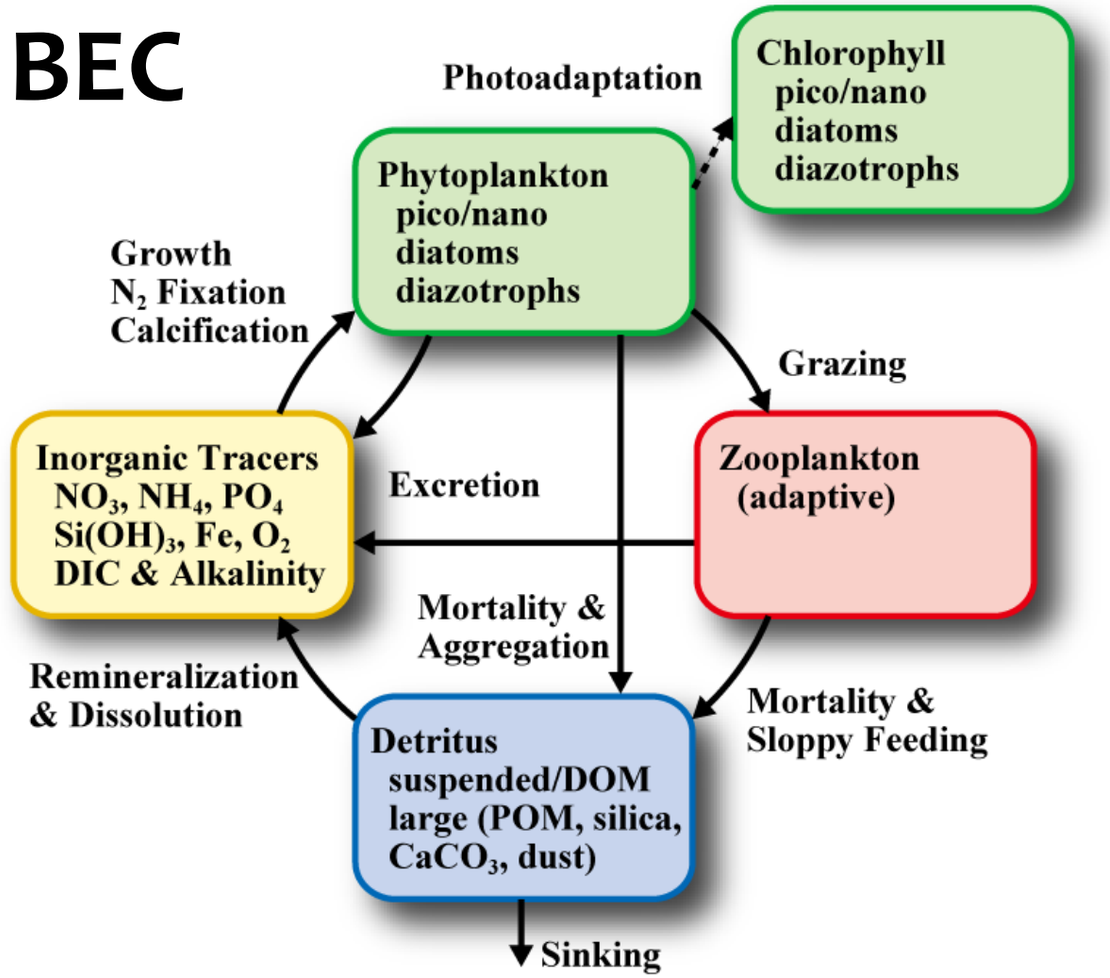
Recently, my colleague Takaki developed **a high-res. North Pacific model** (1/12-1/4 deg.) **using ROMS** that can represent the pathway of the Kuroshio and the formation of NPIW realistically.



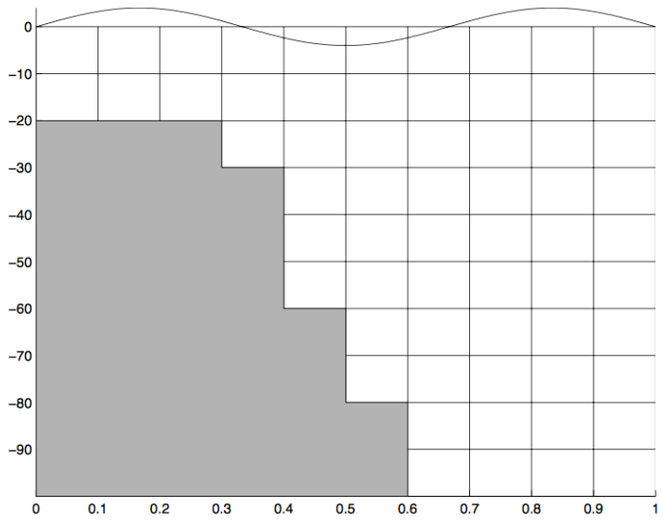




I want to revisit sedimentary iron transport using the model, and decided to **port BEC to ROMS**.

# BEC


Photoadaptation
Chlorophyll
pico/nano
diatoms
diazotrophs
Phytoplankton
pico/nano
diatoms
diazotrophs
Growth
$N_2$ Fixation
Calcification
Grazing
Inorganic Tracers
$NO_3$, $NH_4$, $PO_4$
$Si(OH)_3$, Fe, $O_2$
DIC & Alkalinity
Excretion
Zooplankton
(adaptive)
Mortality &
Aggregation
Remineralization
& Dissolution
Mortality &
Sloppy Feeding
Detritus
suspended/DOM
large (POM, silica,
$CaCO_3$, dust)
Sinking

# **POP** (z-coordinate)




Figs of the vertical coordinates are from Marshall et al. (2004)

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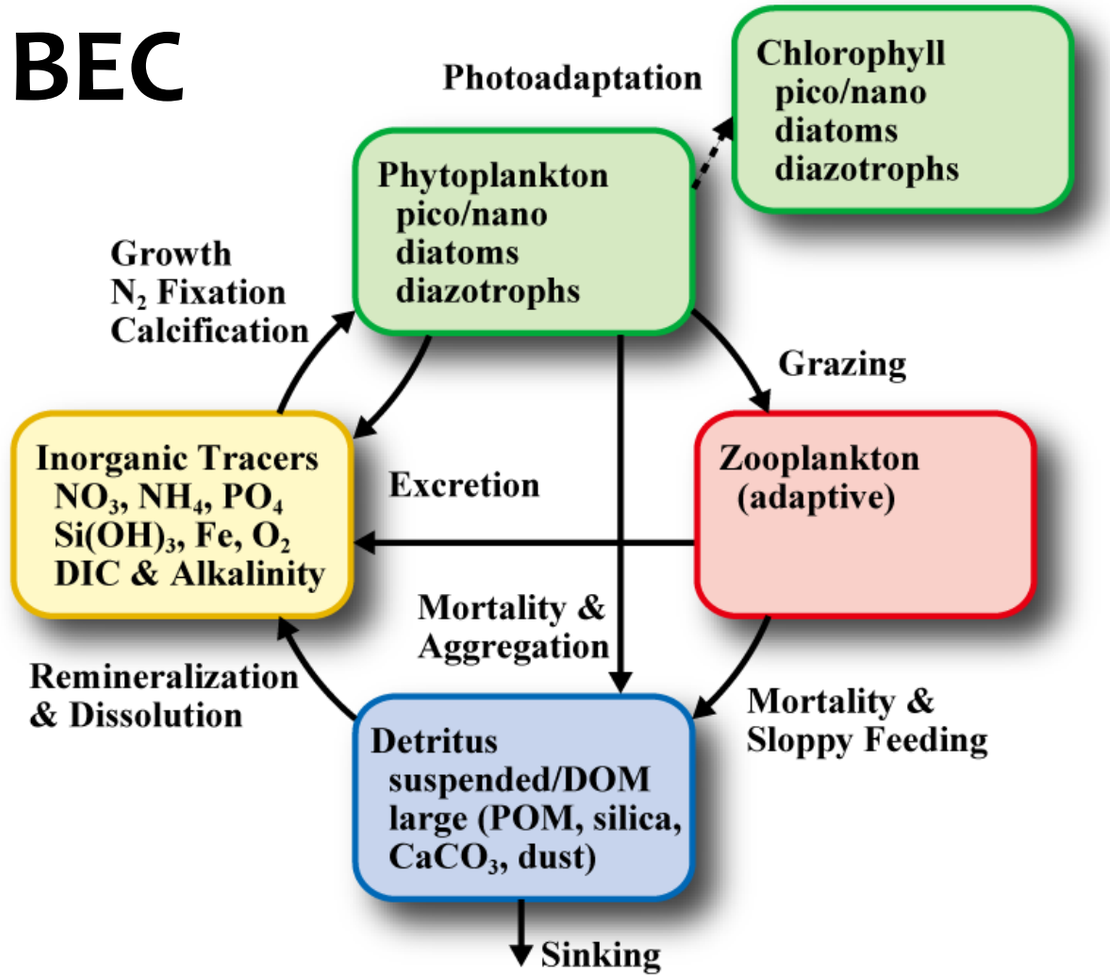

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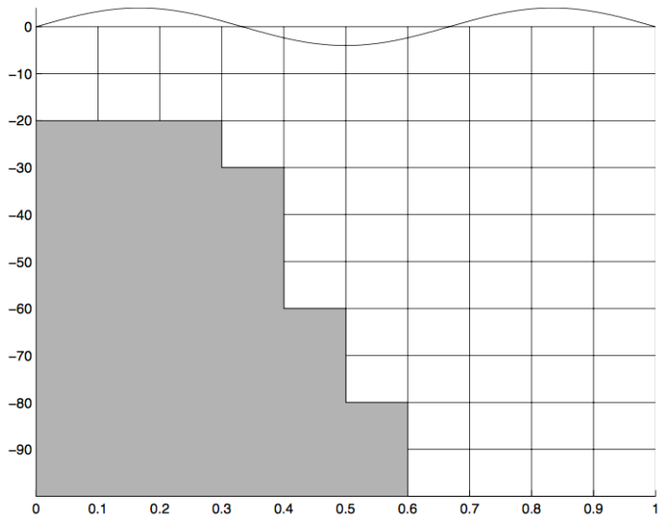


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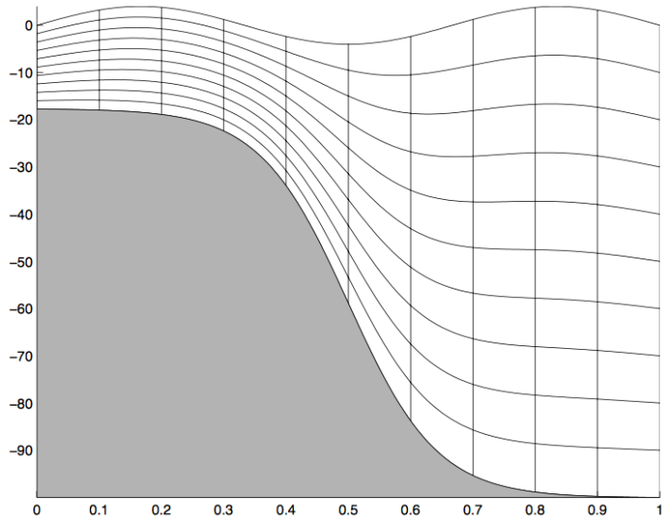
# **ROMS** (s-coordinate)

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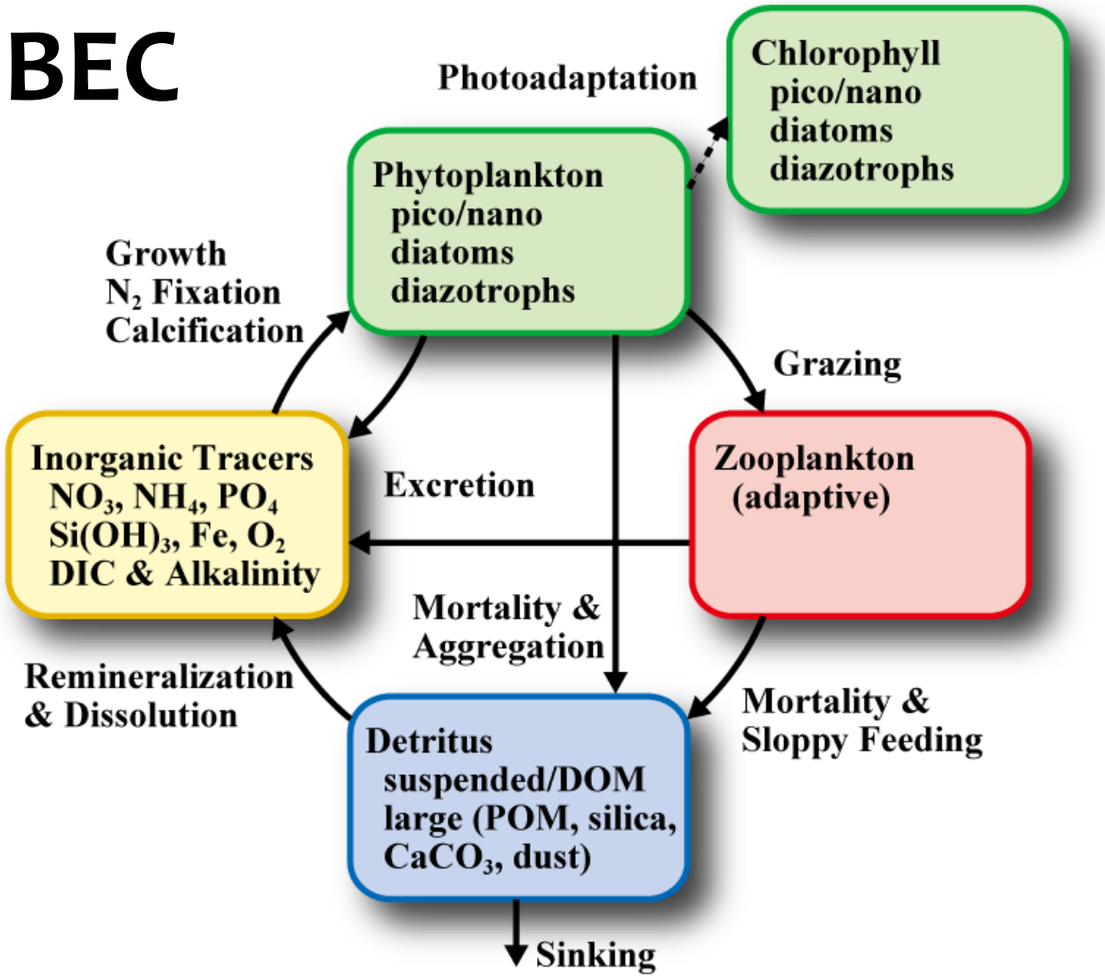

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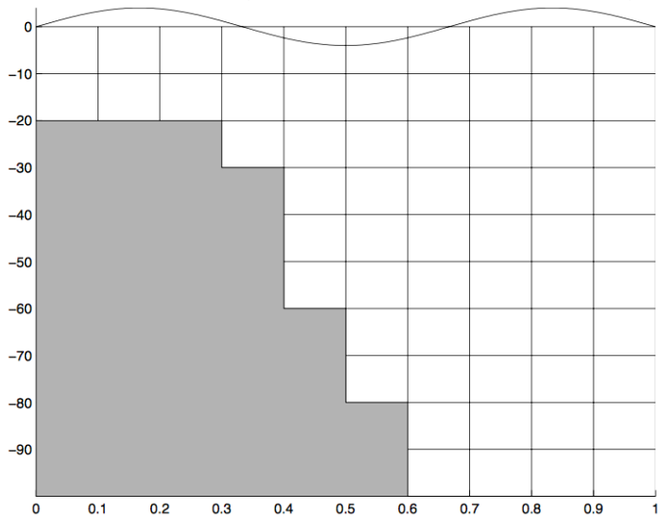


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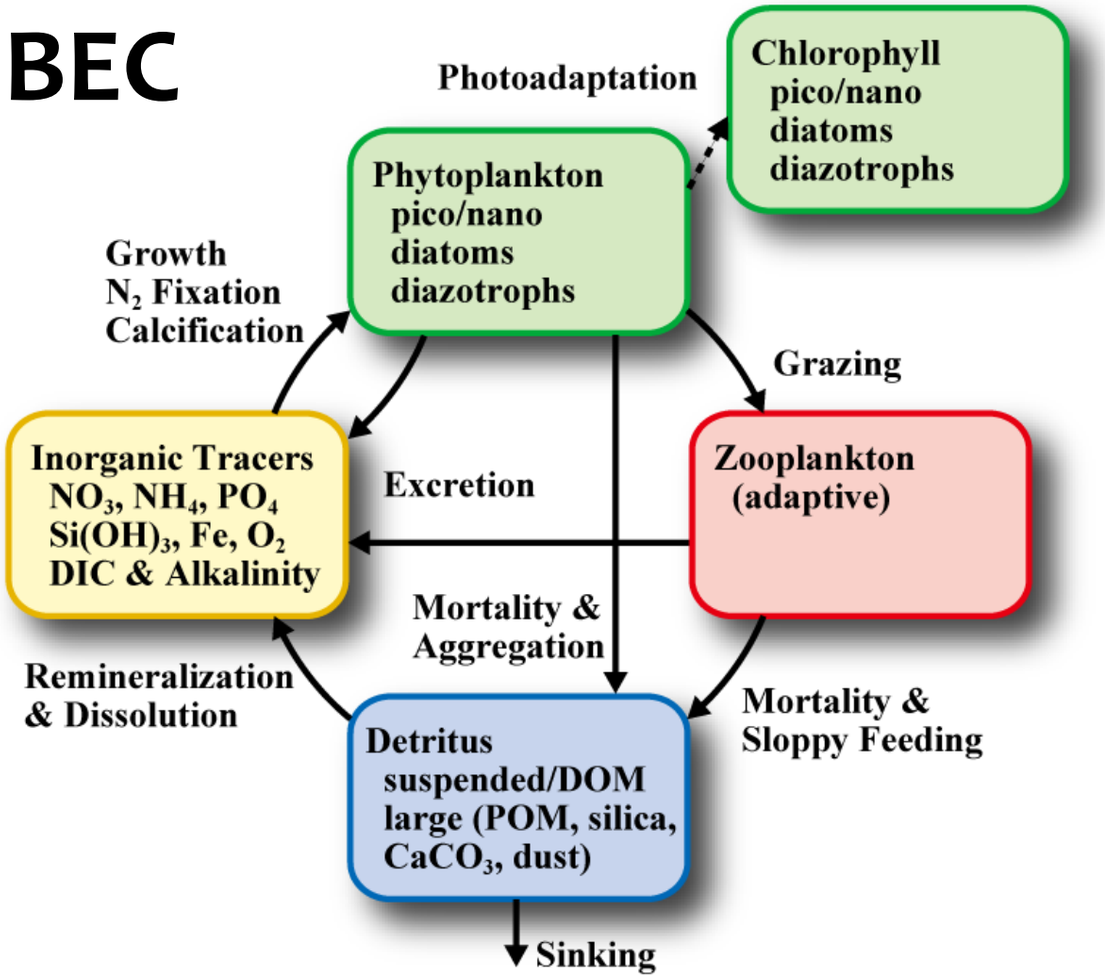


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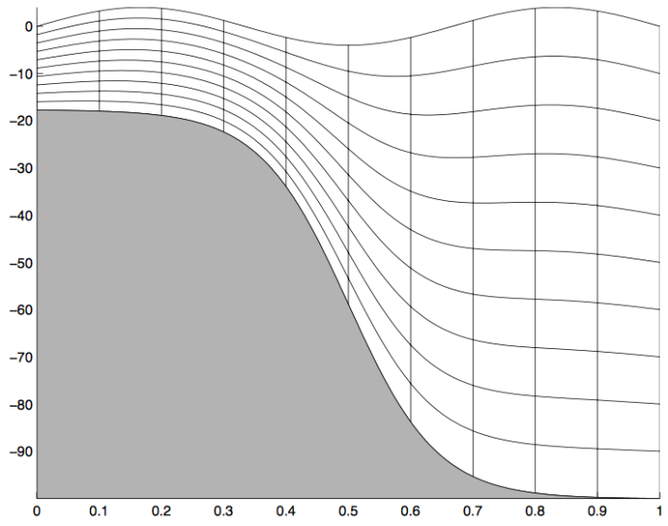


popmini_mod.F

- calculates **depth(z) of the *s*-coodinate,** and **passes it to BEC**
- handles modules used in BEC depending on POP

# Experiments by ROMS+BEC

| | 1D-model | 3D mid-res. | 3D high-res. |
|---|---|---|---|
| **Domain** | 50°N, 145°W | 20°S-65°N, 109°E-75°W | |
| **H & V reso.** | 45 layers | 1°, 45 layers | 1/12°-1/4°, 45 layers |
| **Simulated period** | 40 years | 30 years | 3 years |

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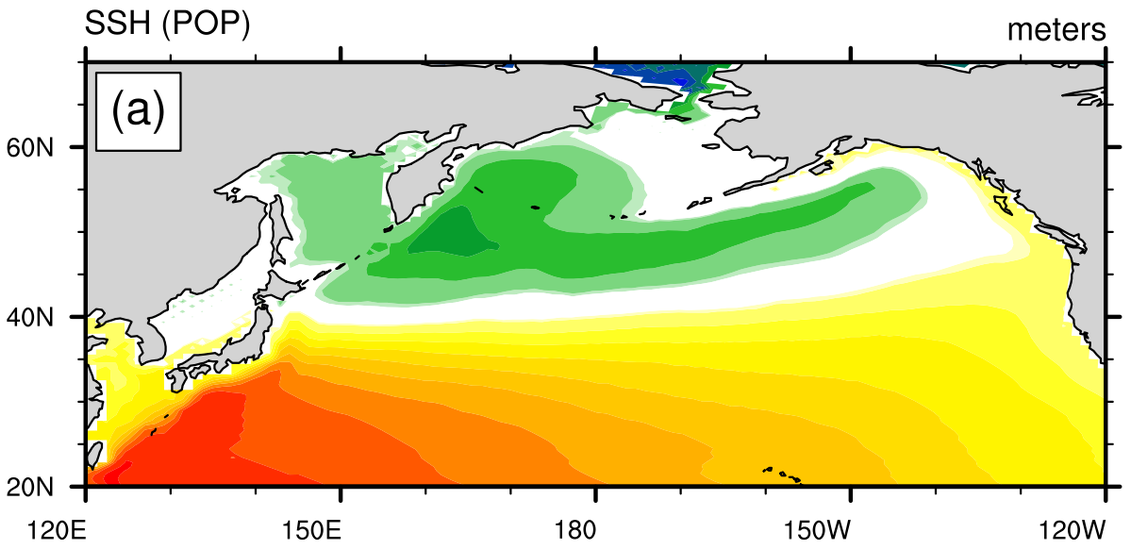
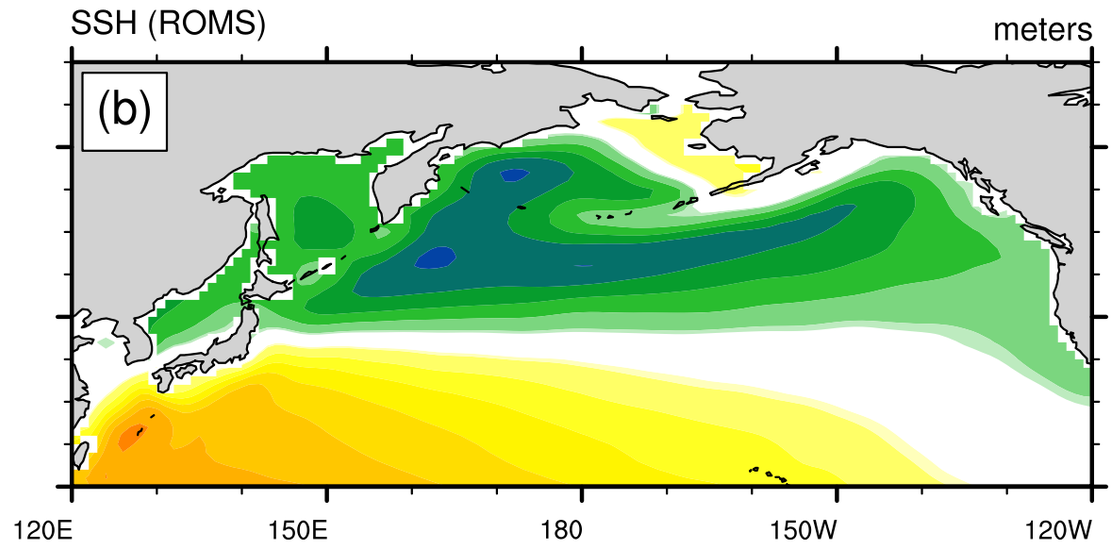
3. Compare the last year data of **ROMS+BEC** w/ **POP+BEC clim**.

# Result: 3D mid-res. (ann. **SSH & vertical vel.** of Jan. at 200m)

## POP

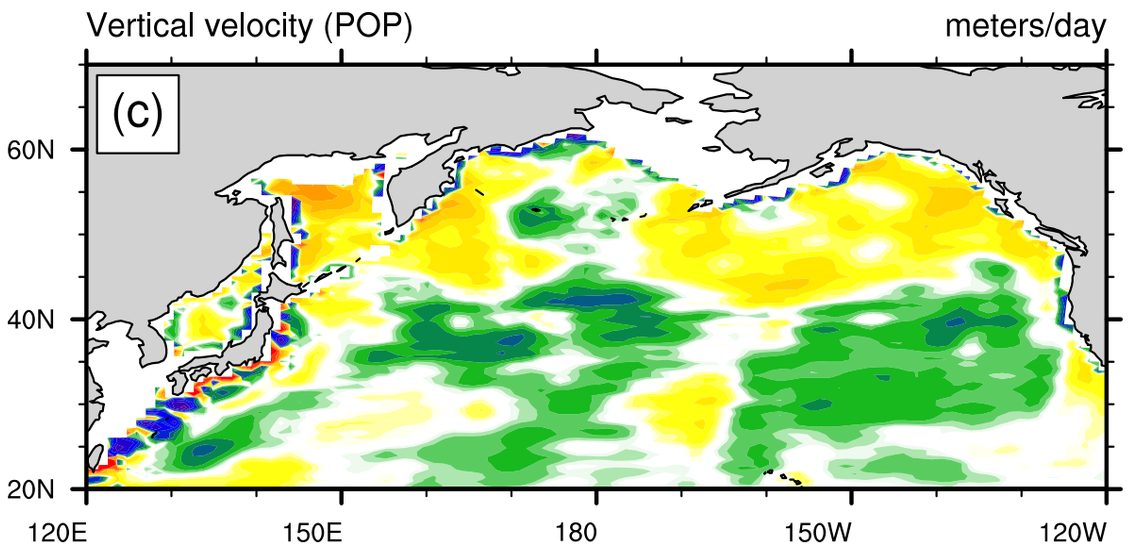


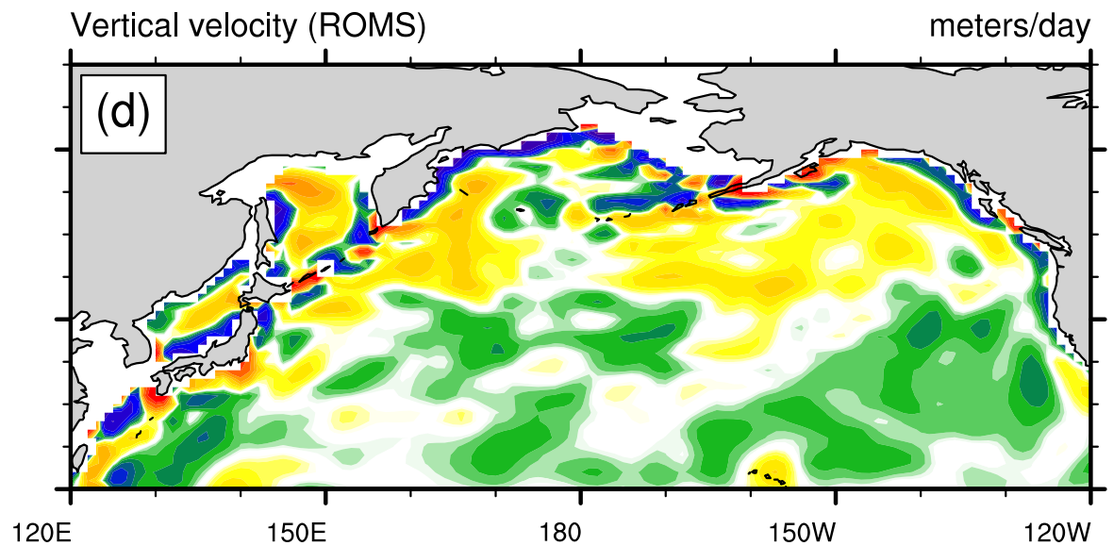

## ROMS

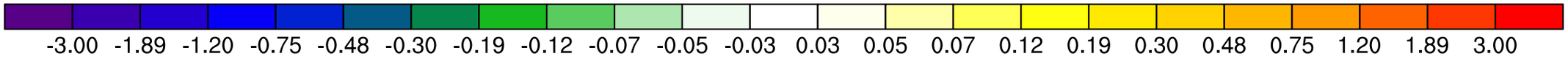








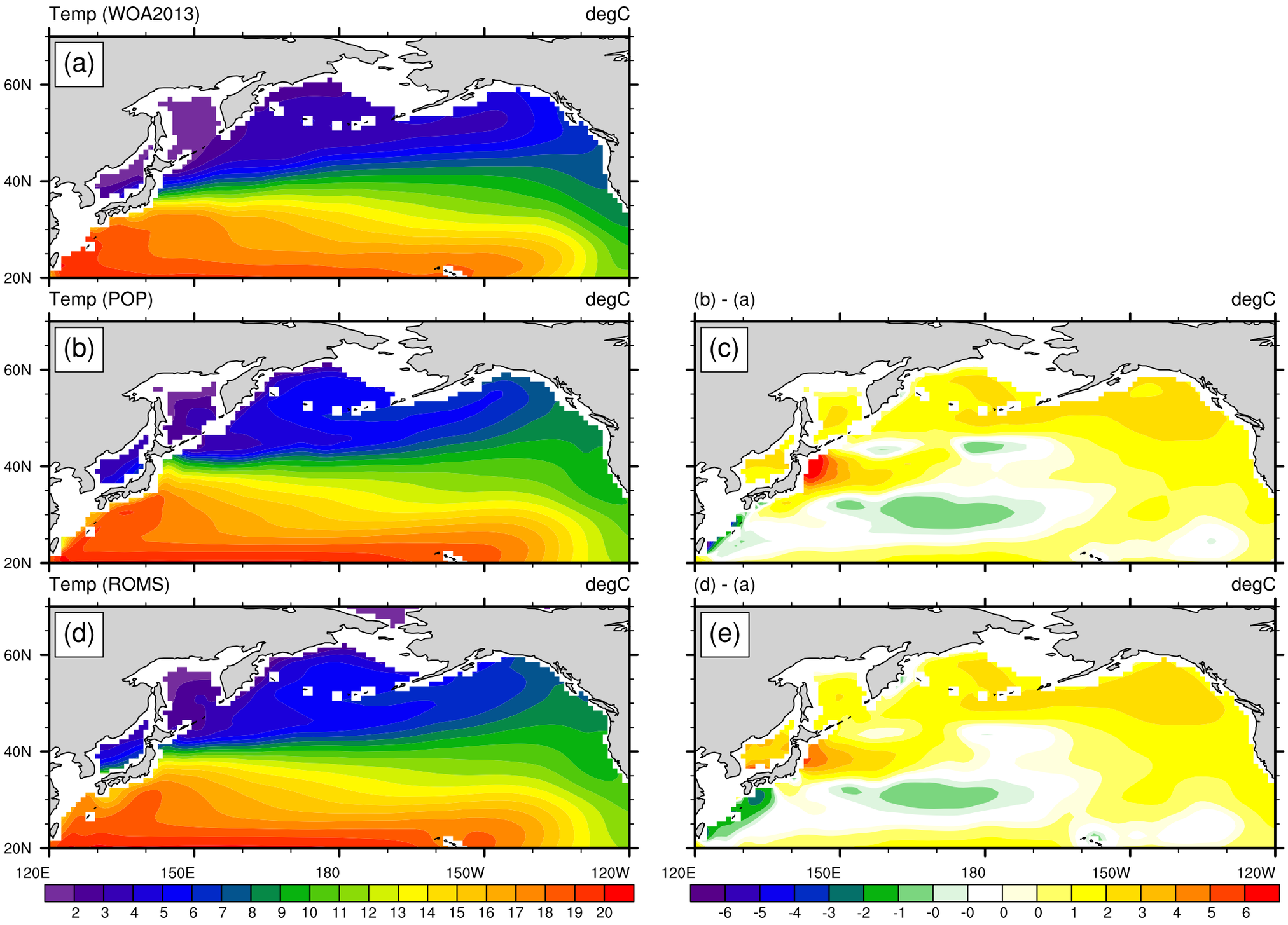



# Result: 3D mid-res. (annual mean **temp.** at 200m)

**WOA**

**POP**

**ROMS**

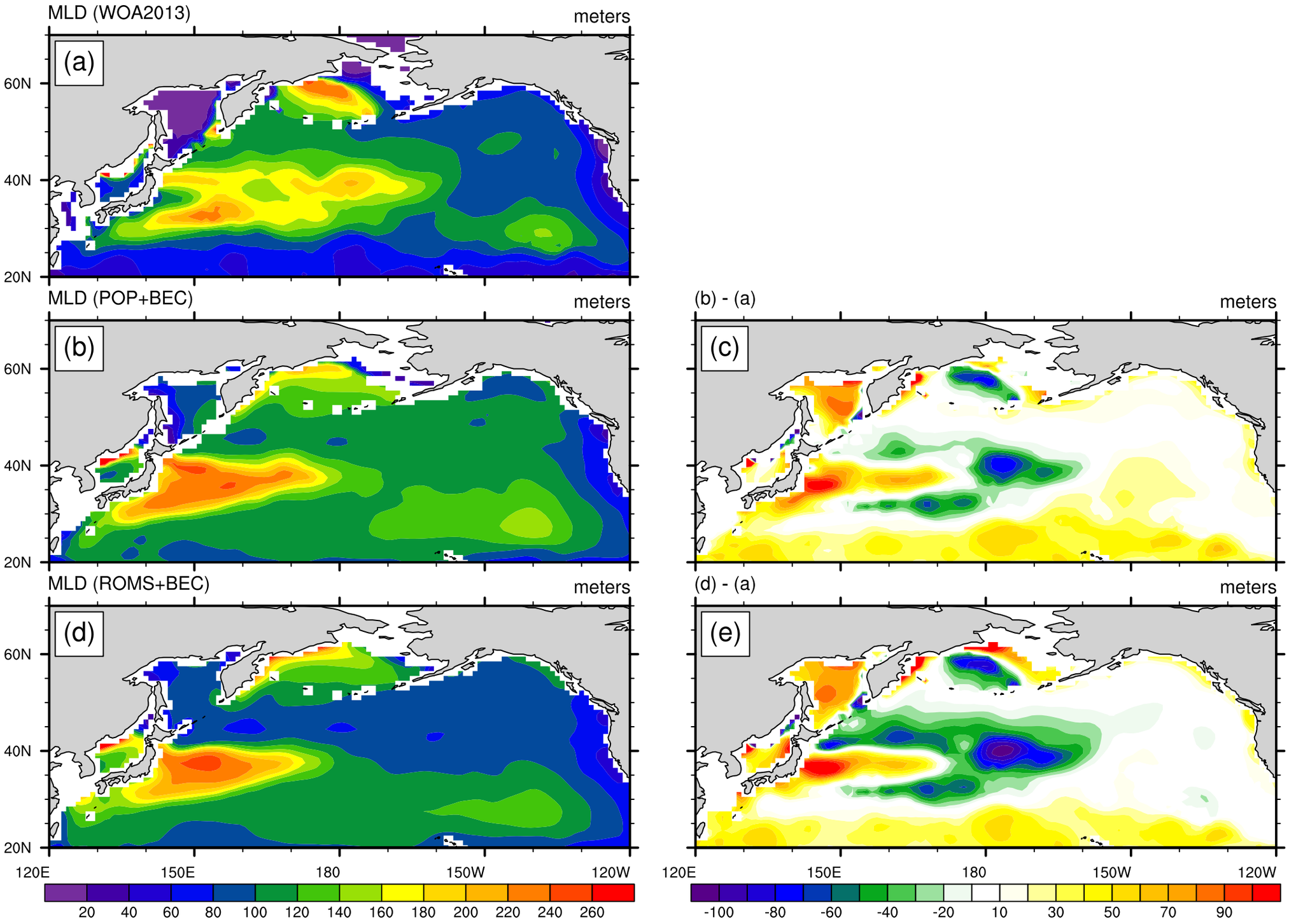


# Result: 3D mid-res. (winter MLD defined as anomaly of $\sigma_9$)

**WOA**

**POP**

**ROMS**

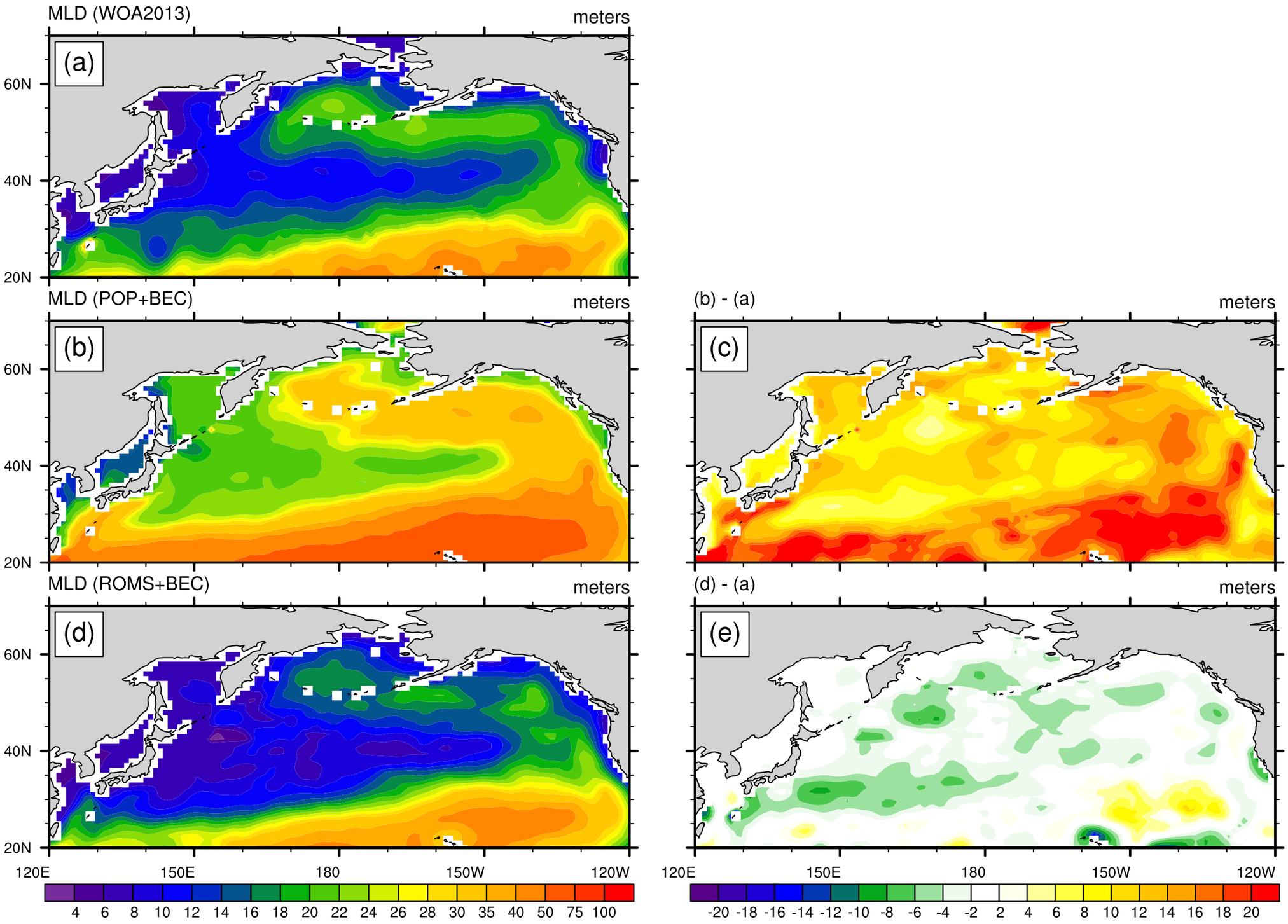


# Result: 3D mid-res. (summer MLD defined as anomaly of $\sigma_9$)

**WOA**

**POP**

**ROMS**

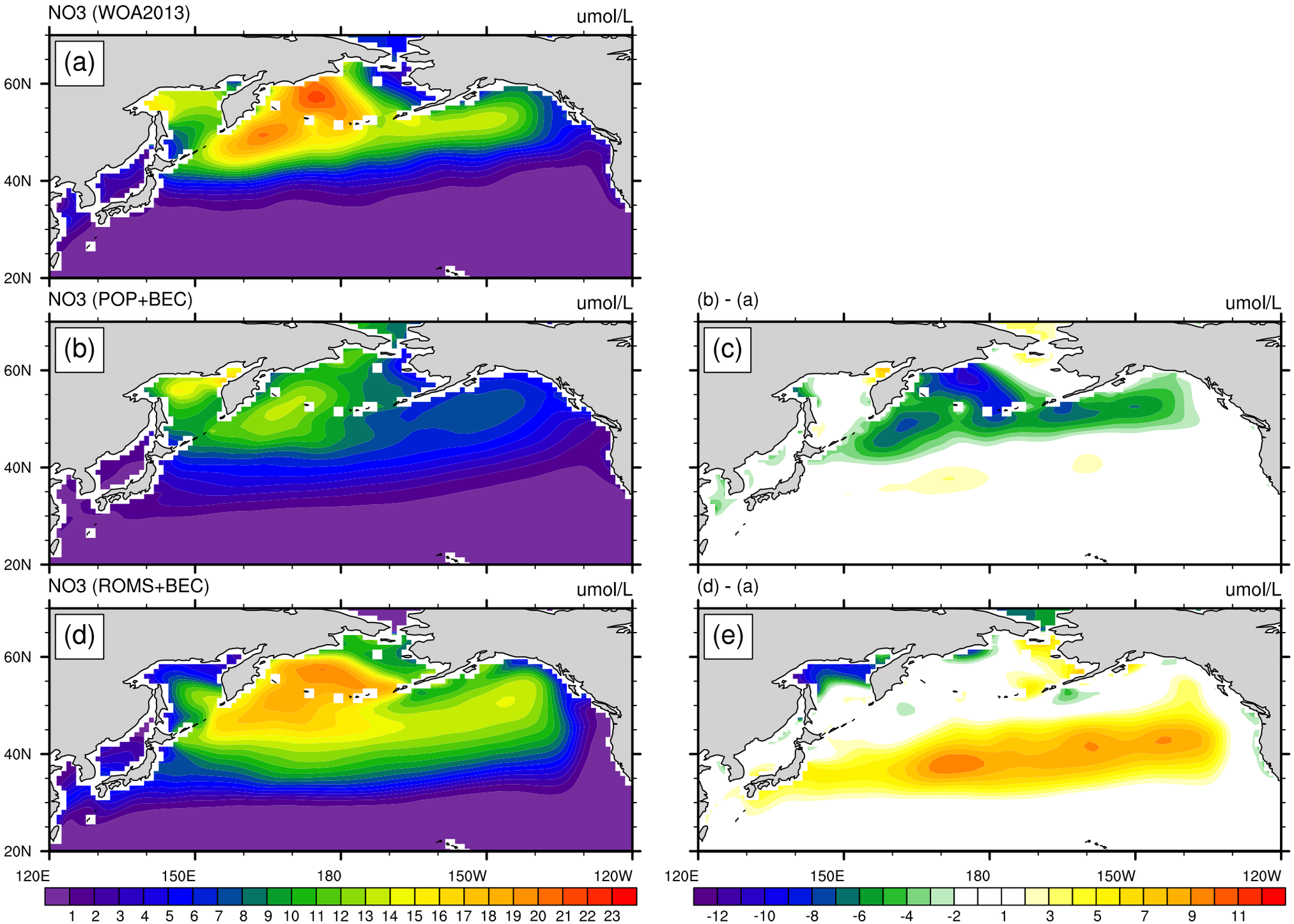


# Result: 3D mid-res. (annual mean $NO_3$ at surface)

**WOA**

**POP**

**ROMS**

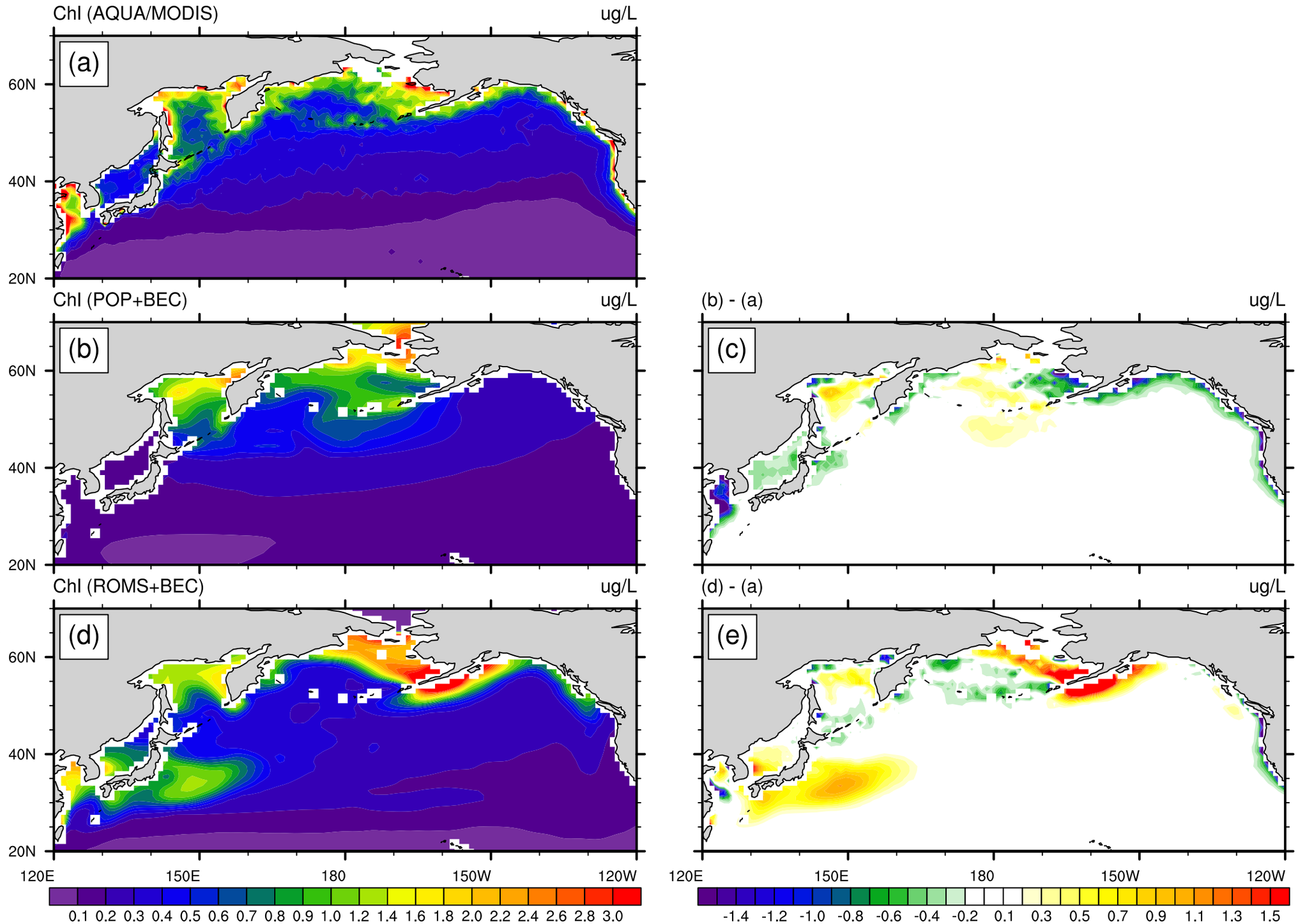


# Result: 3D mid-res. (annual mean **Chl a** at surface)

**AQUA/ MODIS**

**POP**

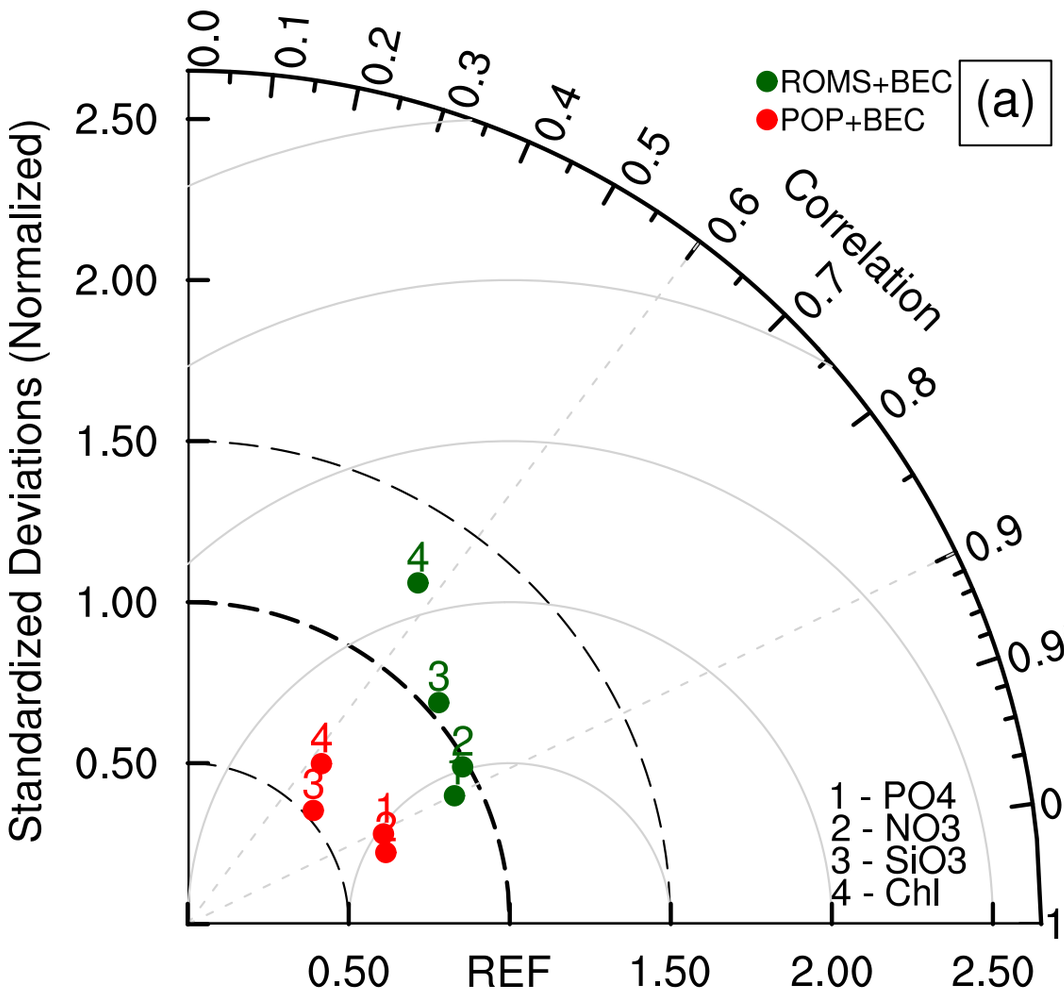
**ROMS**



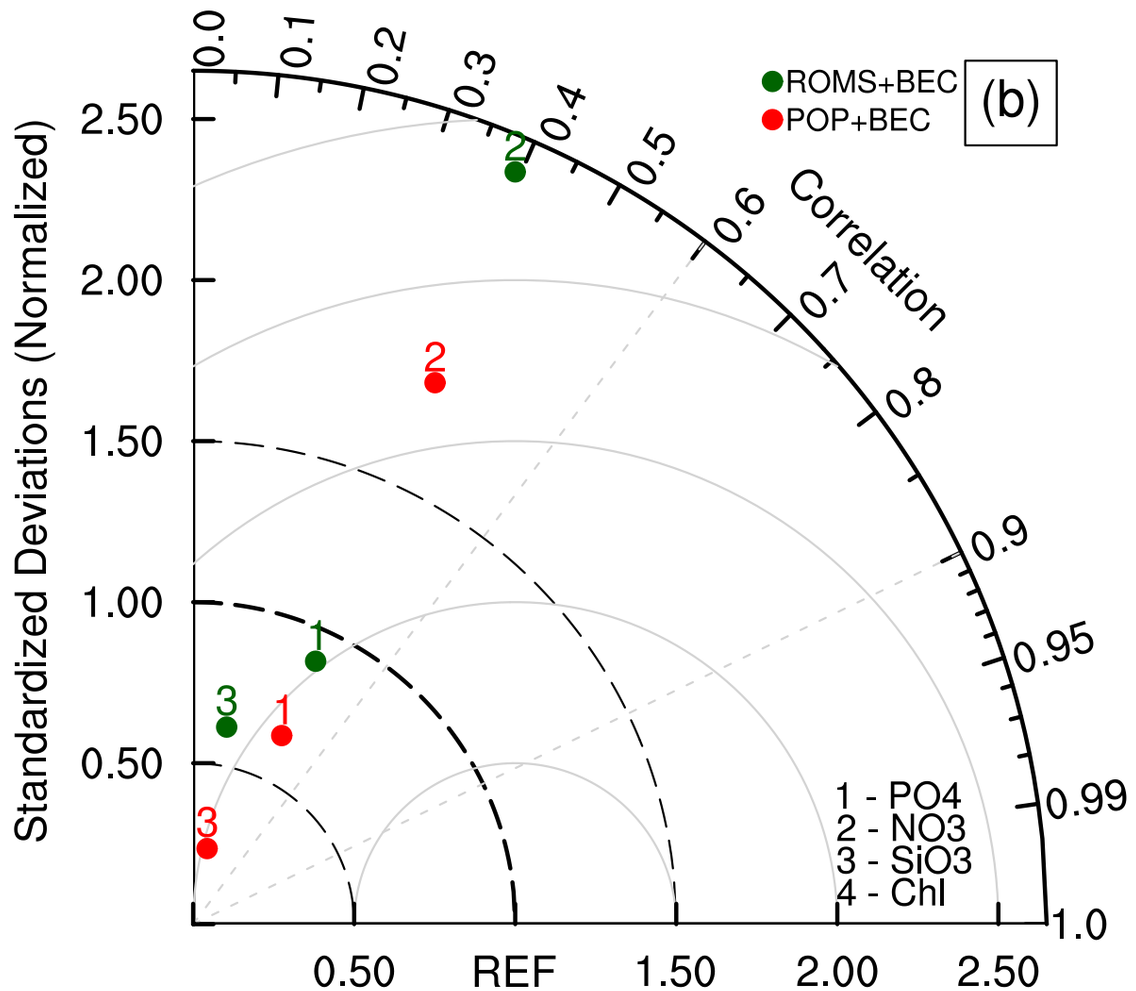
# Result: 3D mid-res.

Statistics are calculated for the North Pacific domain.

## Annual mean spatial



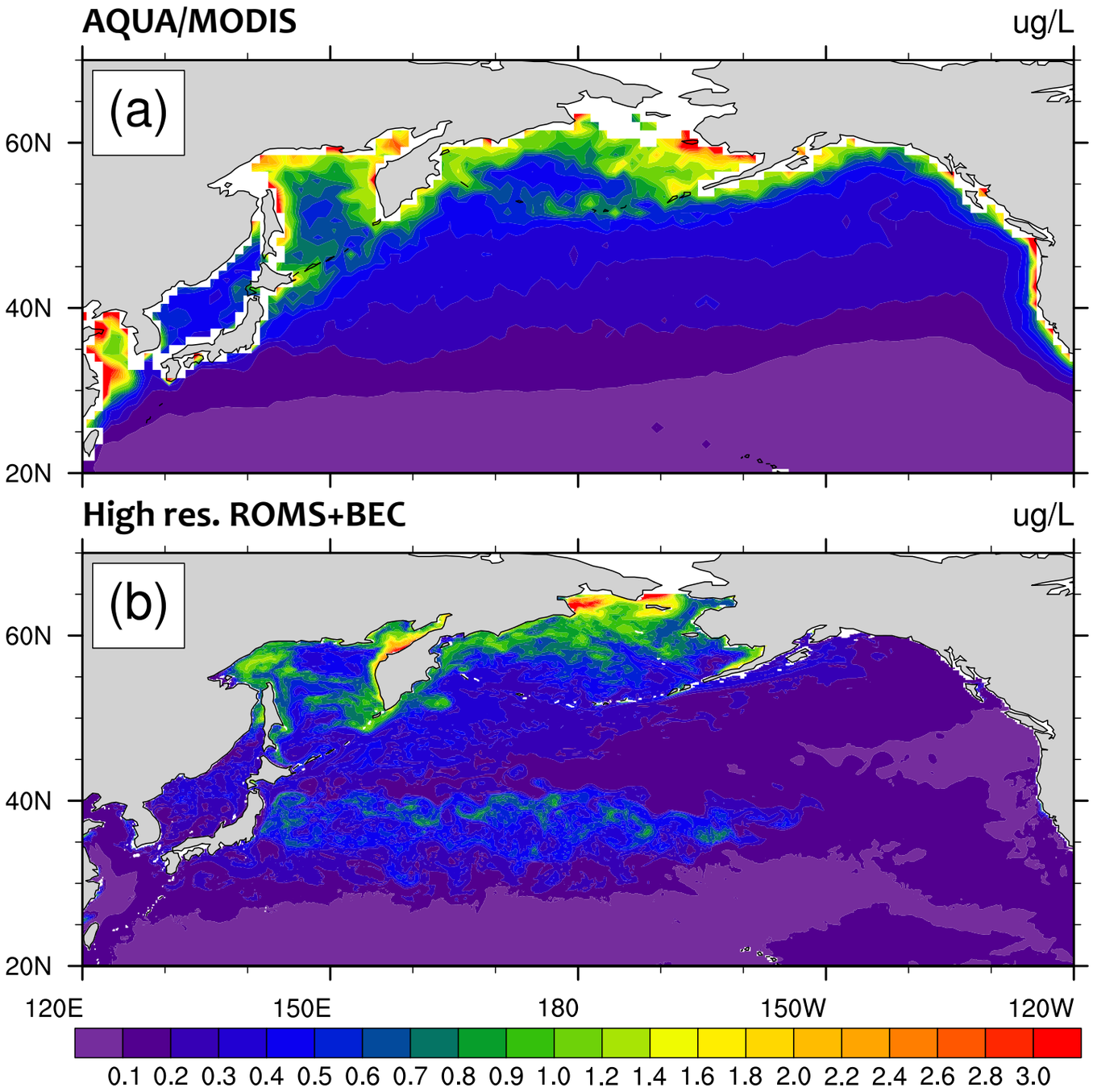

## Seasonal vari.



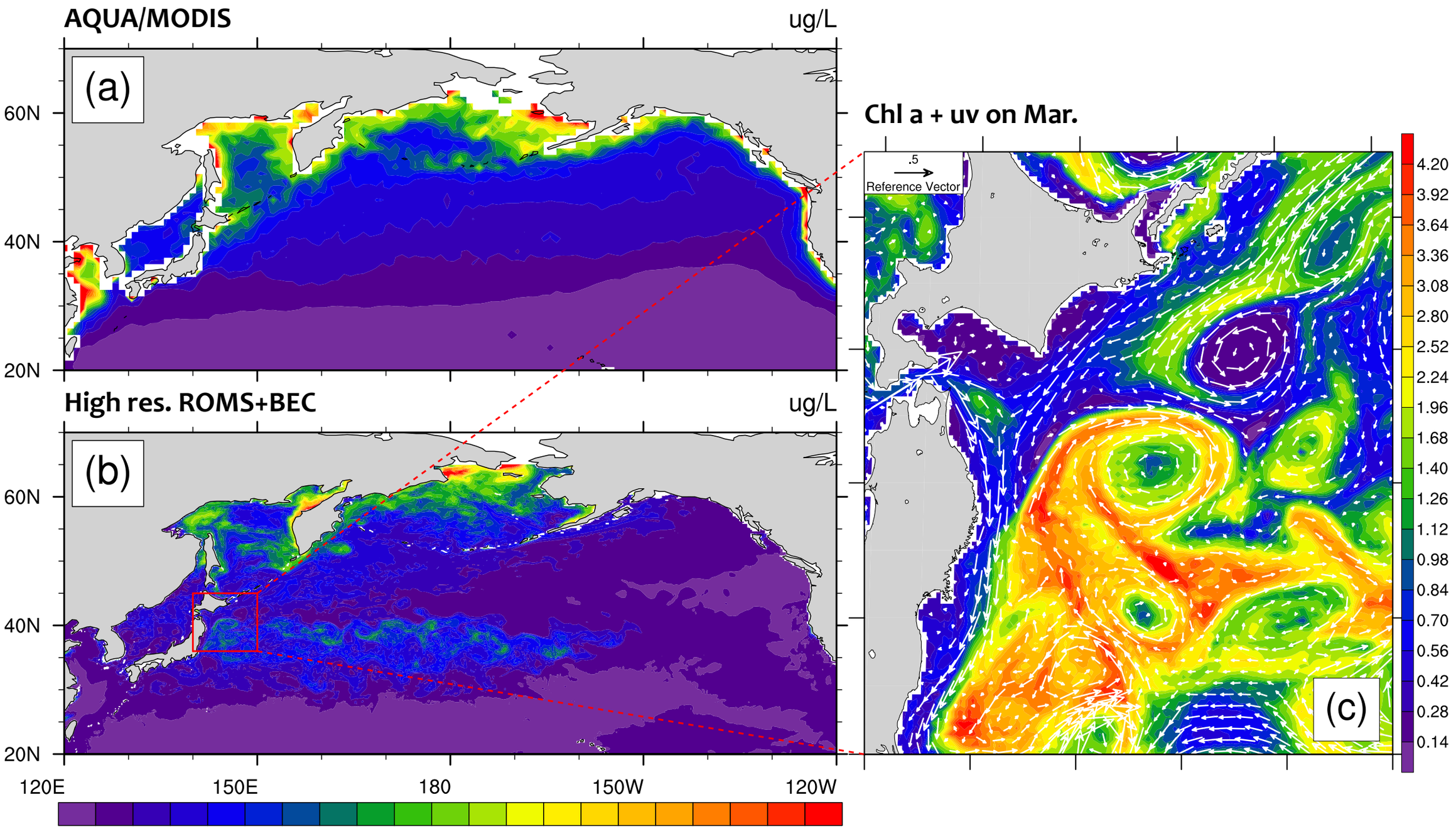

● POP+BEC, ● ROMS+BEC

1. $PO_4$, 2. $NO_3$, 3. $Si(OH)_4$, 4. Chl a

# Result: 3D high-res. (annual mean **Chl a** at surface)



# Result: 3D high-res. (Chl a)



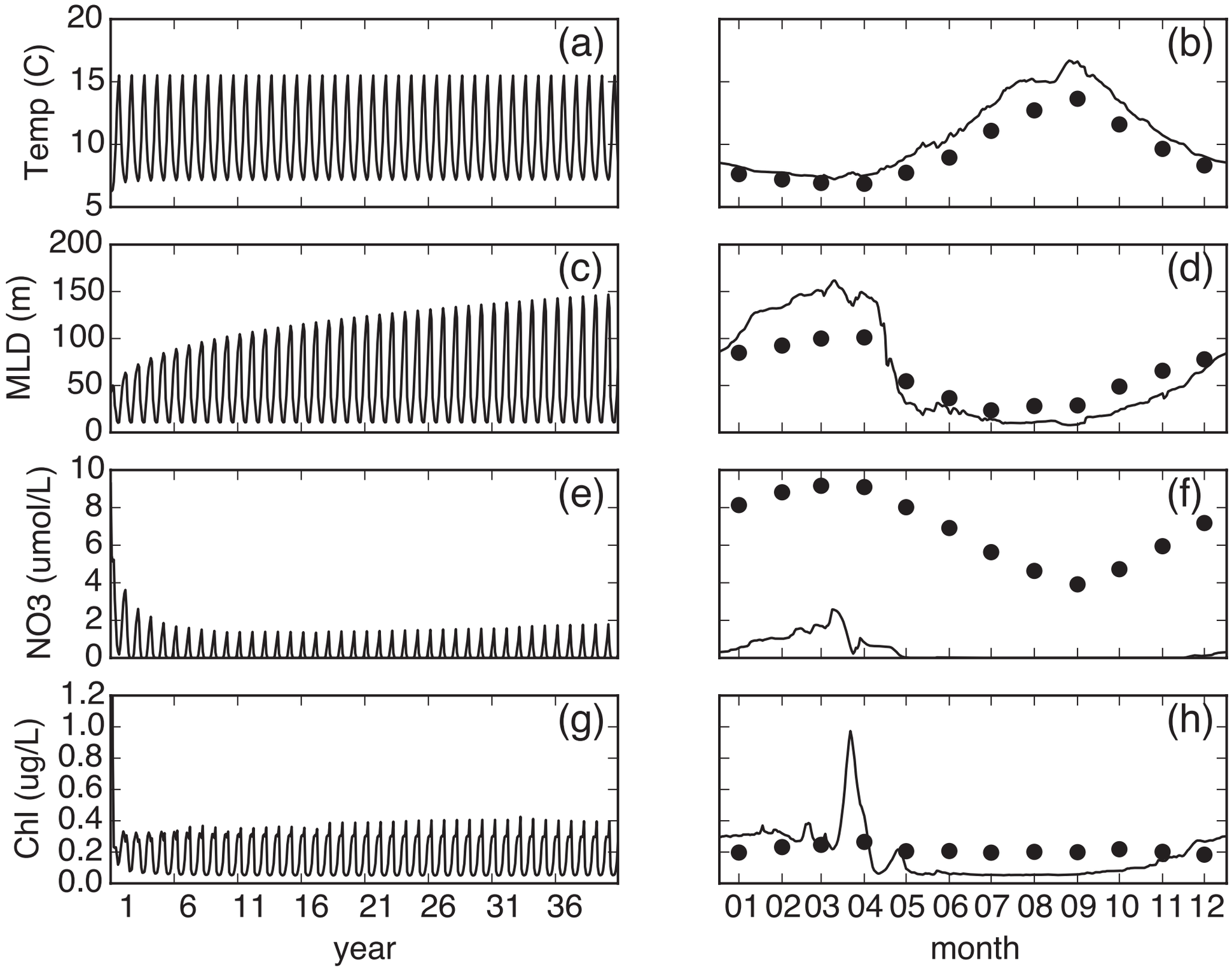
# Conclusions

- **BEC works fine with ROMS** using *s*-coordinate.
  - The model skill simulating obs. is **comparable** to that in POP+BEC.
  - **Some systematic differences** needed to be addressed are observed.

- **Some BGC tendencies are calculated in the ocean model routines**; we have not taken into account yet.
  - virtual fluxes for DIC and ALK
  - gas exchange

- The **high-res. model** results are **impressive**, but it is a matter **how to initialize the model** owing to its high computational cost.

# Result: 1D-model



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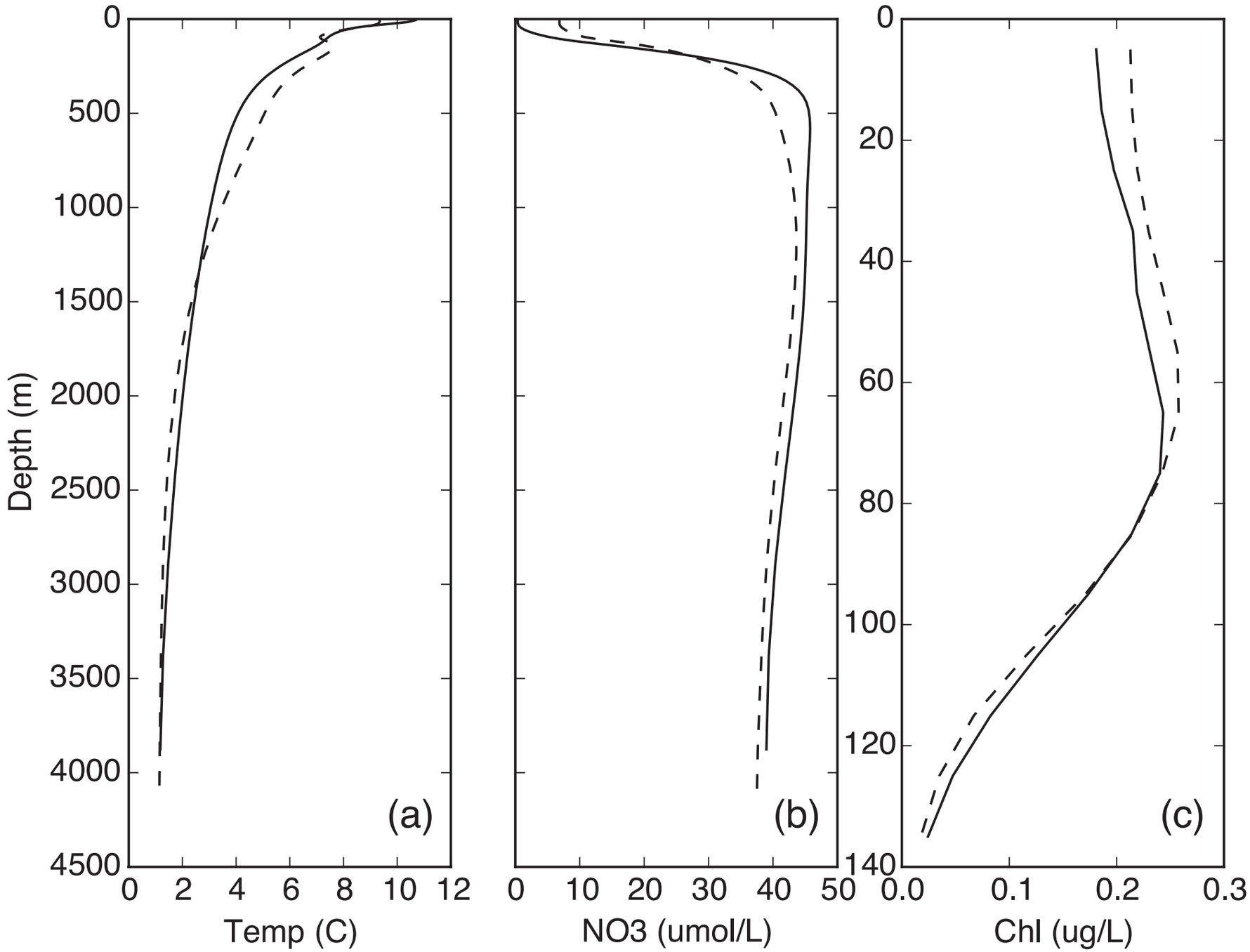

# Result: 3D mid-res. (Fe)

**POP**

**ROMS**