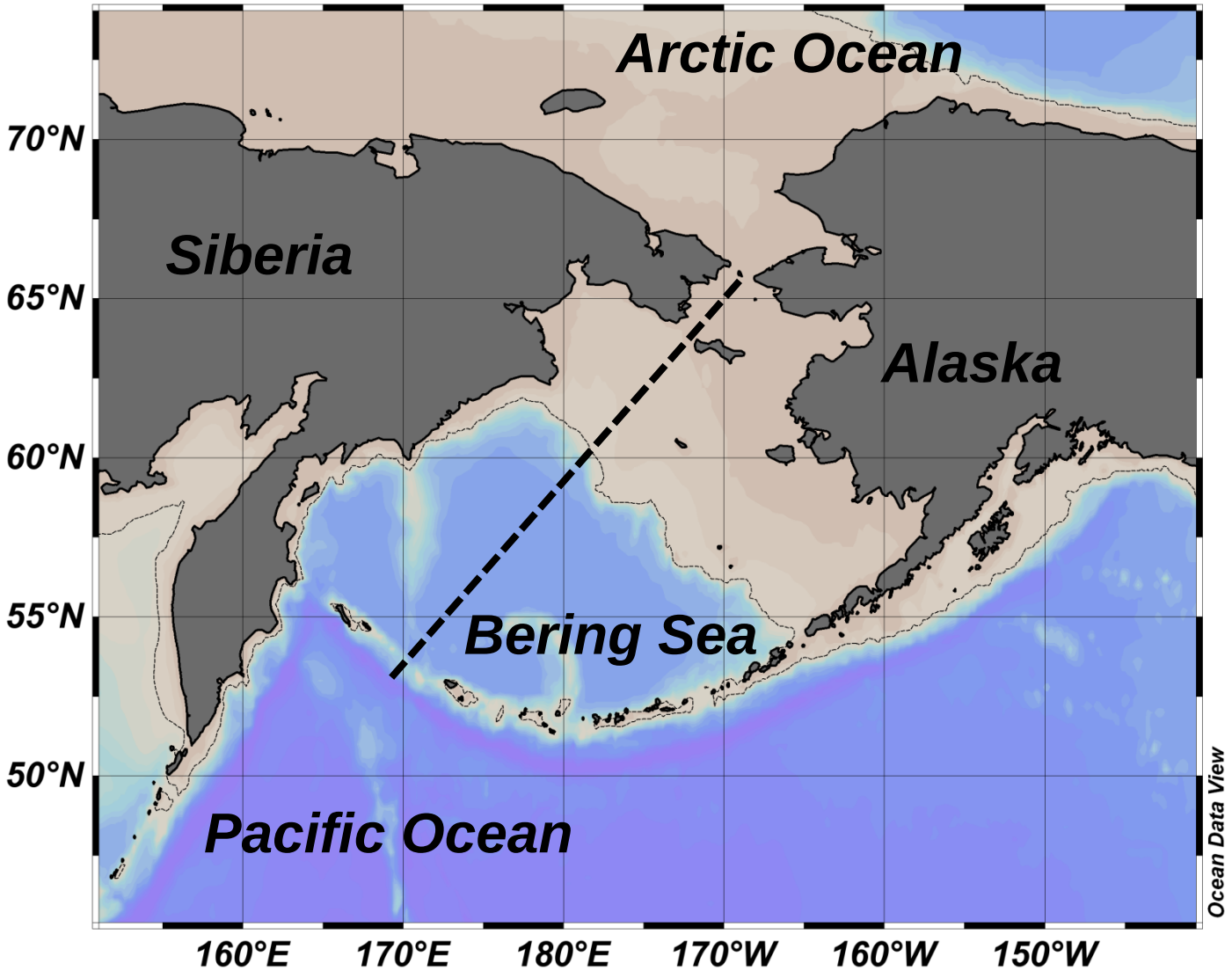
New approach for primary productivity assessment in the Bering Sea

***Kirill Kivva*[1,2]**

[1] Lomonosov Moscow State University, Moscow, Russia.

[2] Russian Federal Research Institute of Fisheries and Oceanography (VNIRO), Moscow, Russia.

Introduction

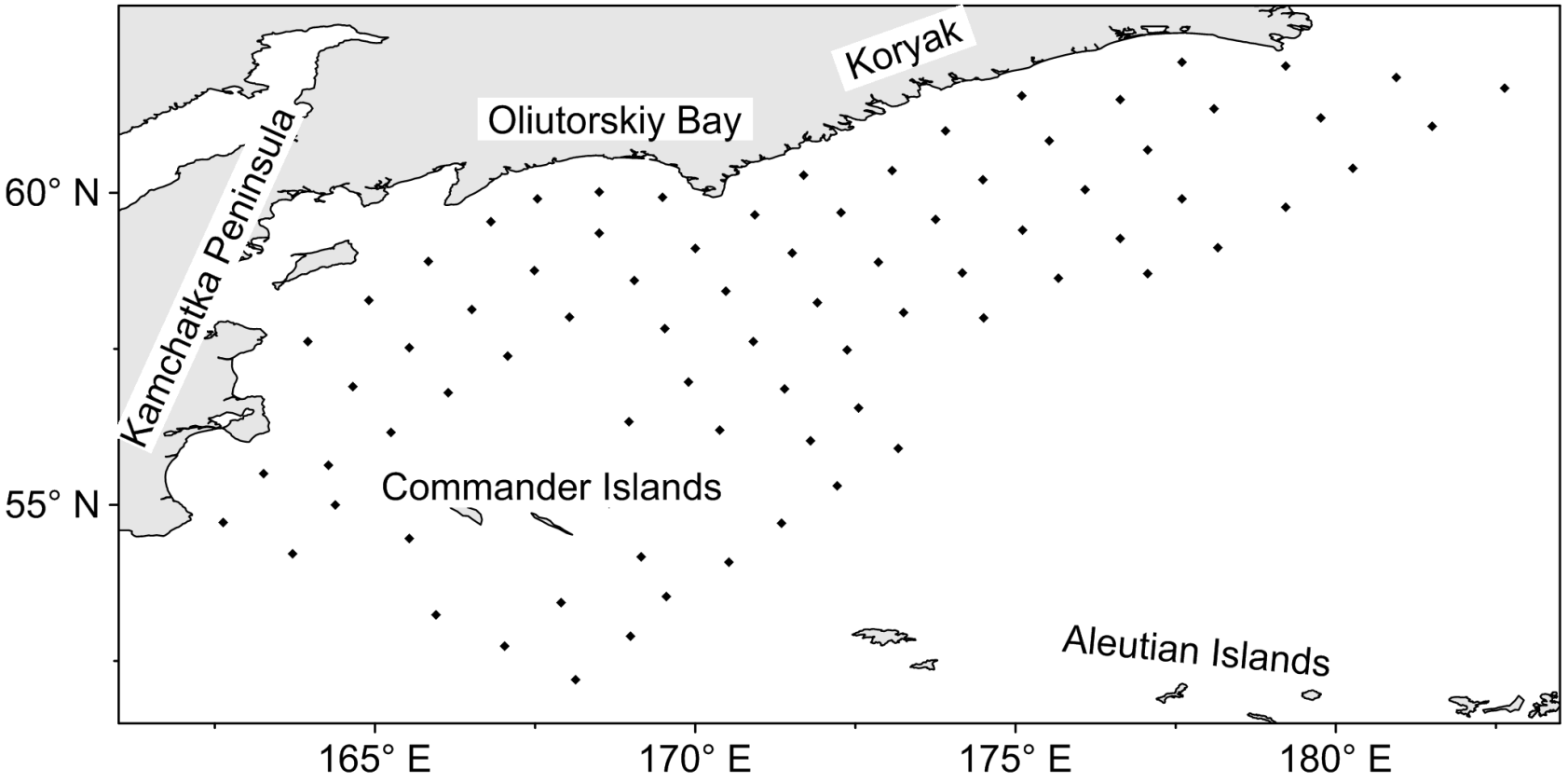


Introduction

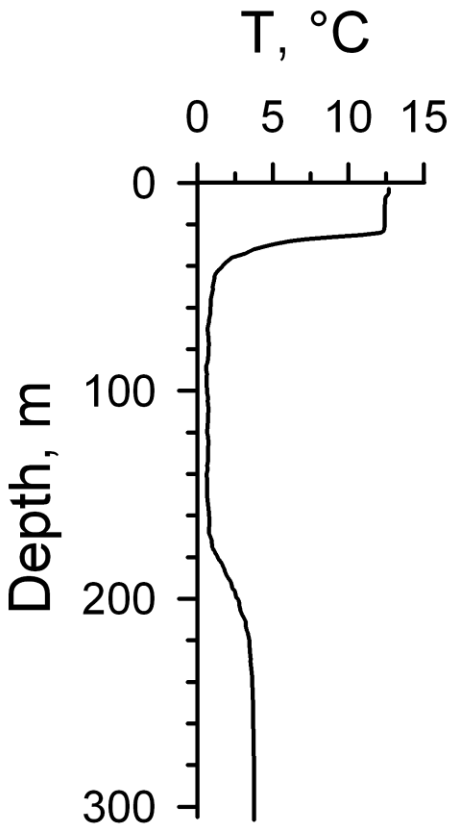
- Very few studies have examined the western Bering Sea annual/seasonal primary production (Arzhanova et al. 1995, Brown et al. 2011).
- Recent relatively high resolution nutrient data exist
- Here is the possibility to get a proxy for PP

Methods

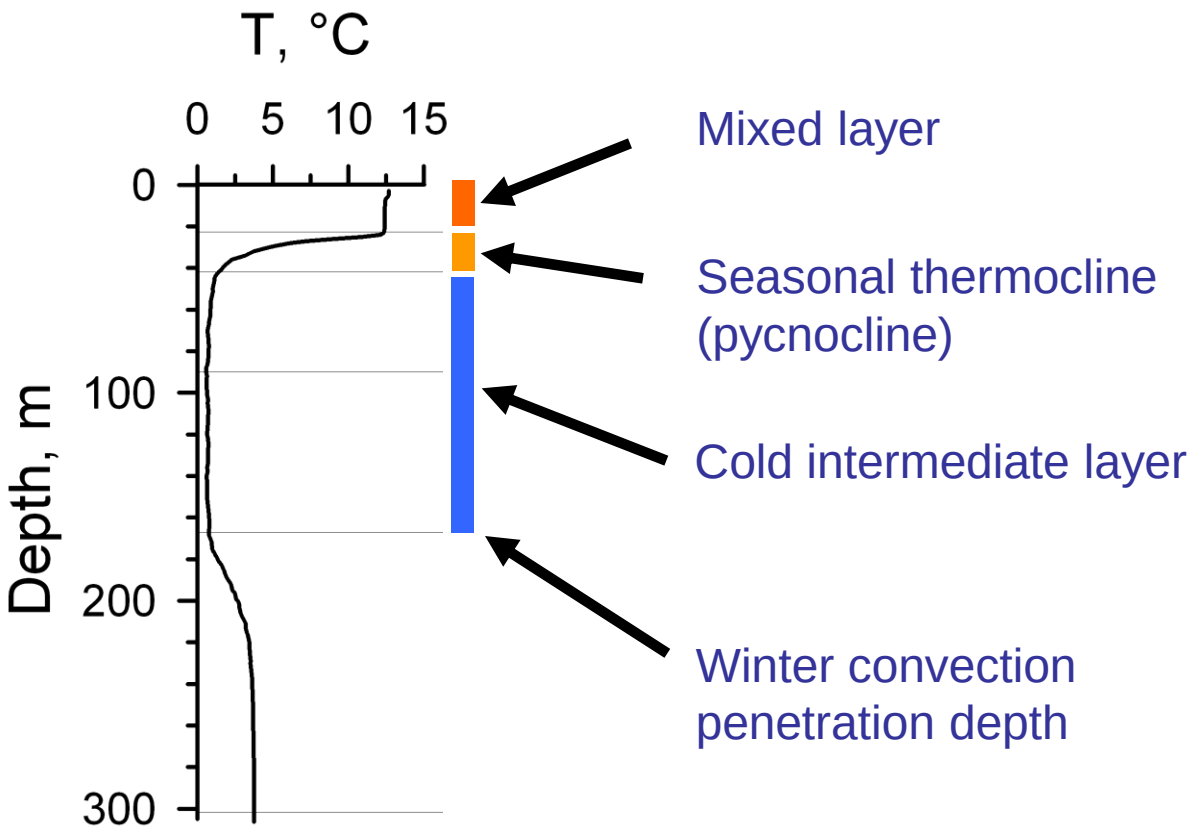
- Survey aboard Fisheries R/V “Professor Kaganovsky” (TINRO-Center), September 2012
  - ***90 CTD stations***: SBE 9 plus Sealogger
  - ***80 sampling stations***: O_2, SiO_3^{2-}, PO_4^{3-}, NO_2^-, NO_3^-, NH_4^+



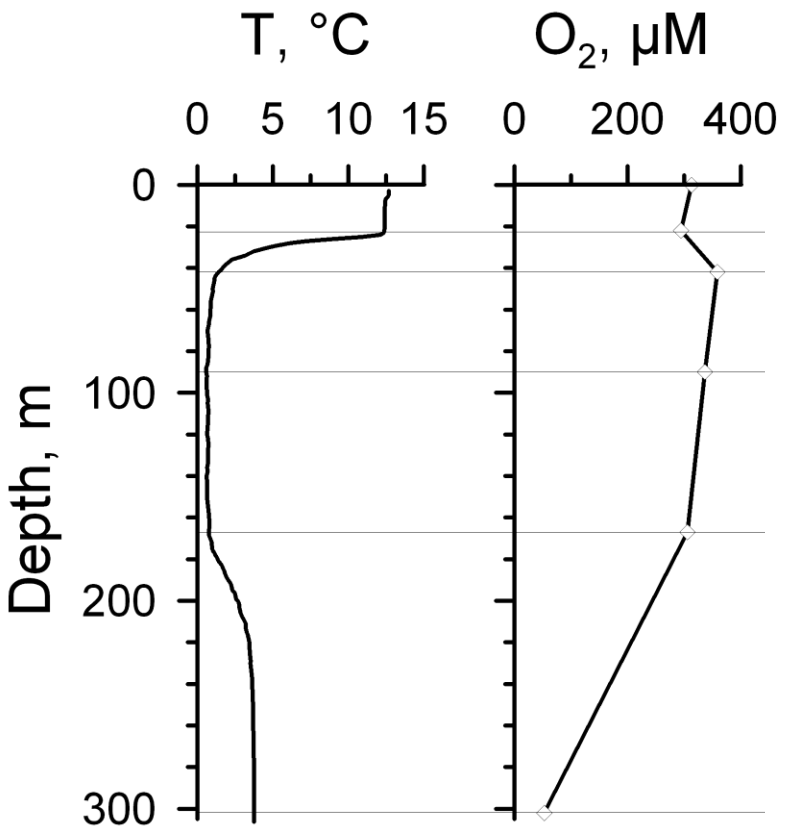
Methods



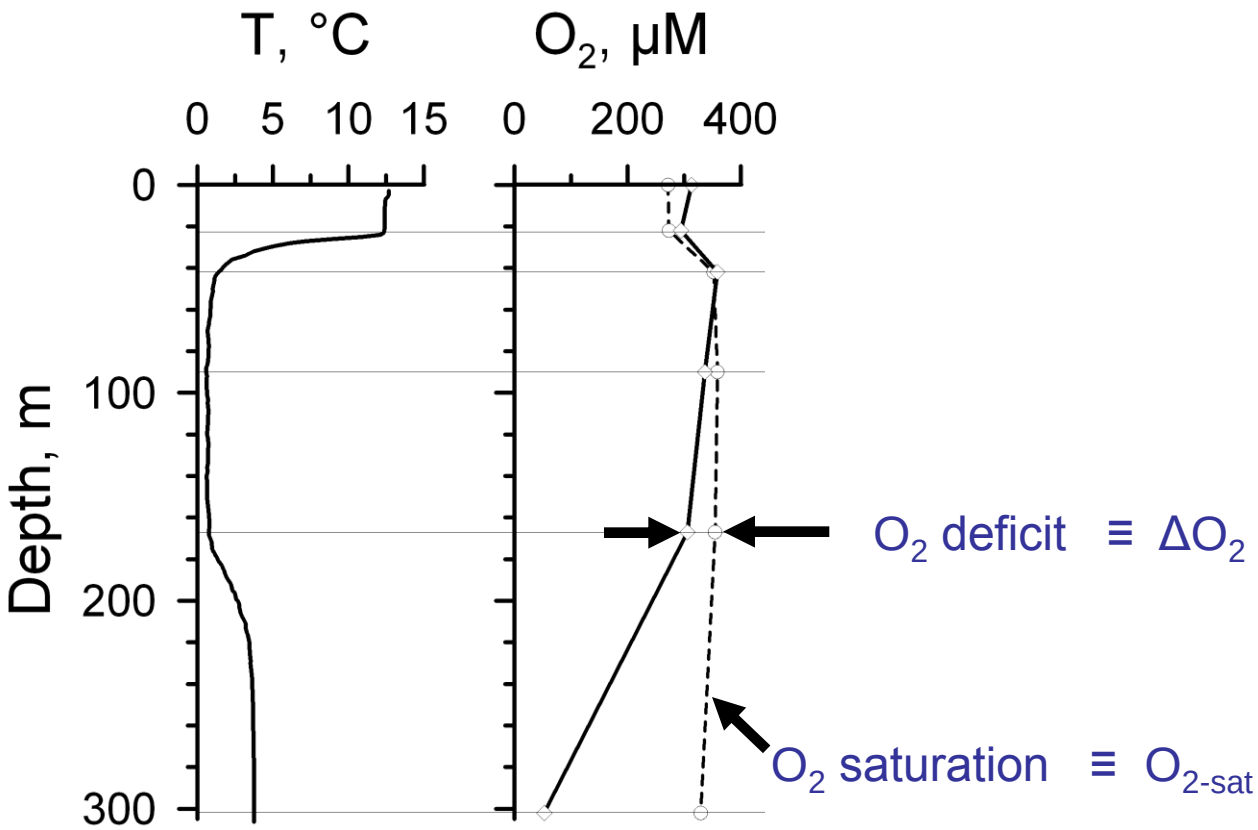
Methods


T, °C
0
5
10
15
0
100
200
300
Depth, m
Mixed layer
Seasonal thermocline
(pycnocline)
Cold intermediate layer
Winter convection
penetration depth

Methods



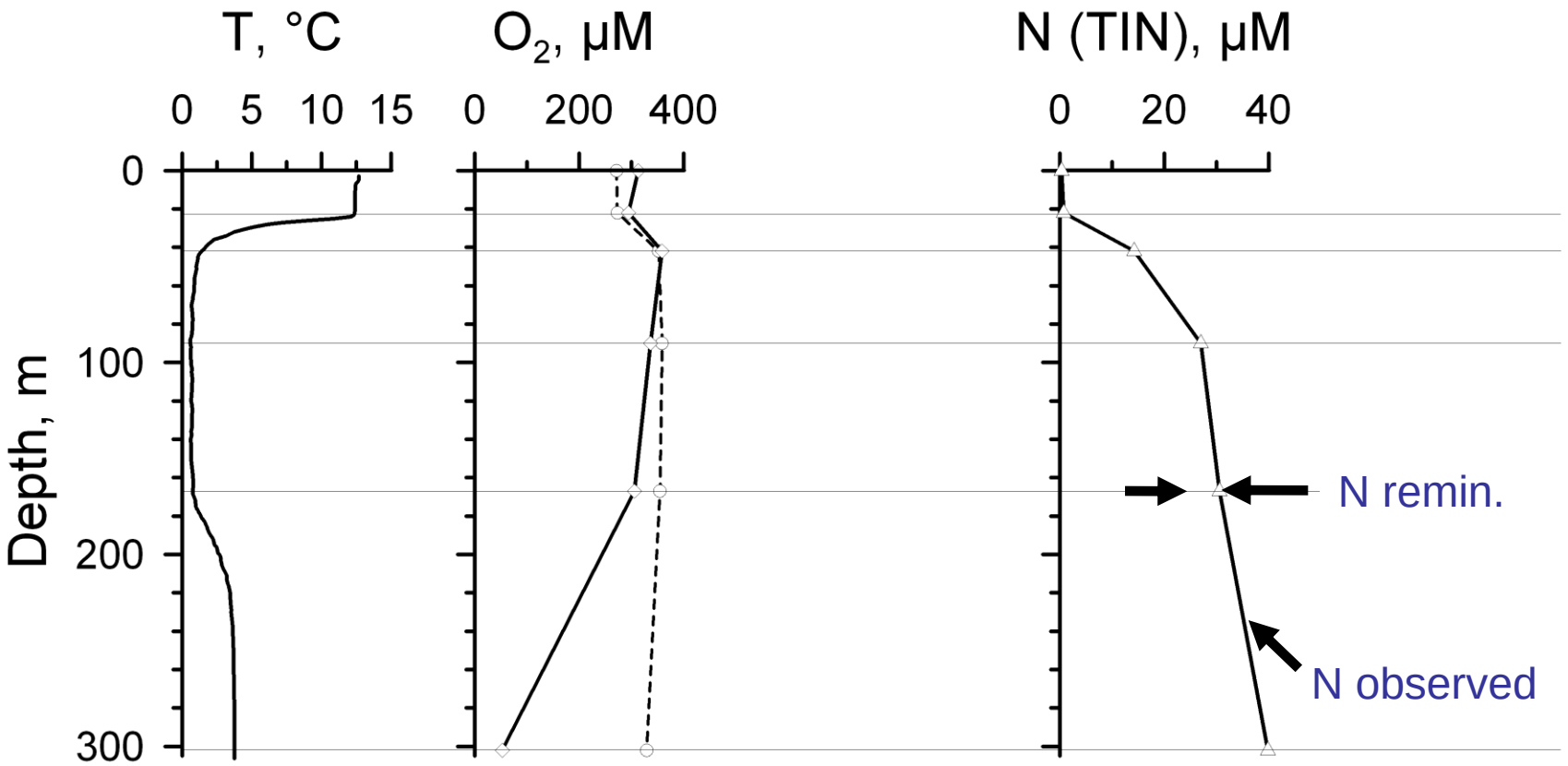
Methods



$\Delta O_2(z_x) \equiv O_{2\text{-sat}}(z_x) - O_2(z_x)$

Assumption: dissolved oxygen decreased mostly due to organic matter mineralization

Methods



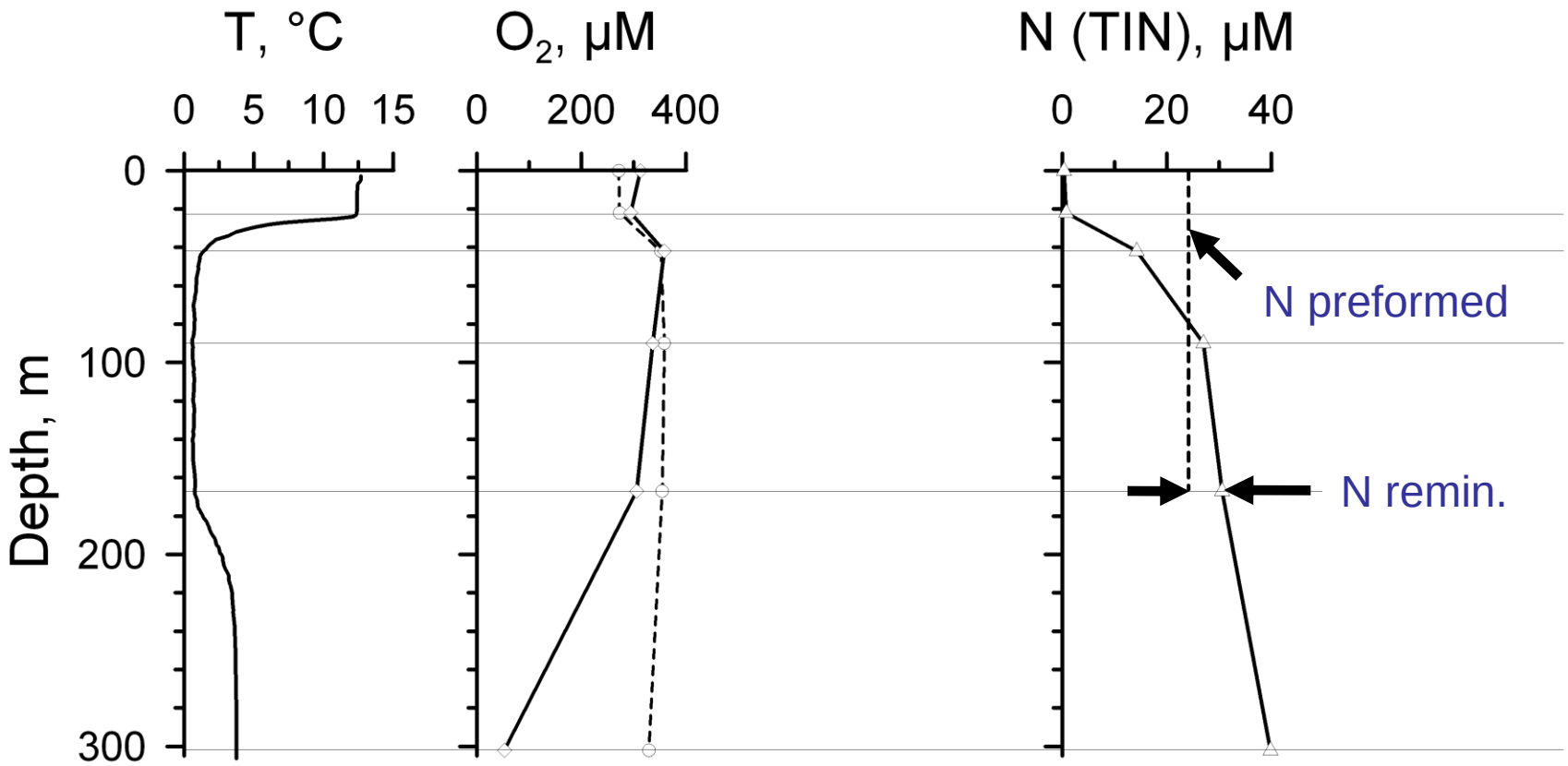
$C_{106}H_{175}O_{42}N_{16}P + 118\ O_2 \rightarrow 106\ CO_2 + 16\ NH_4 + HPO_4^{2-} + 48\ H_2O + 14\ OH^-$

C / O / Si / N / P = 106 / -118 / 23 / 16 / 1

Assumption: nutrients decrease mostly due to organic matter mineralization.

Redfield, 1958
Richards, 1958
Anderson, 1995

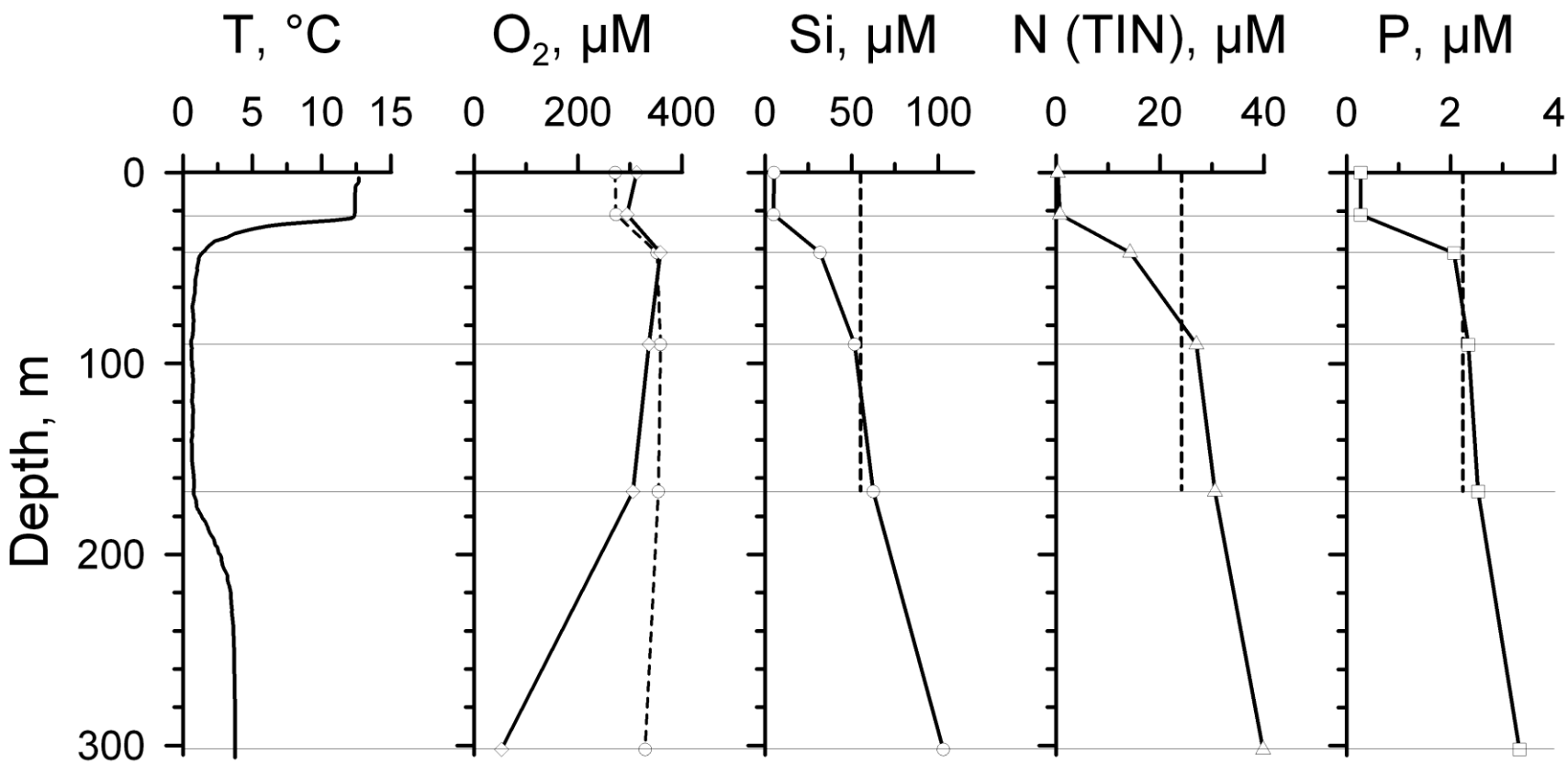
Methods



$N_{remin} = R_N \times \Delta O_2$

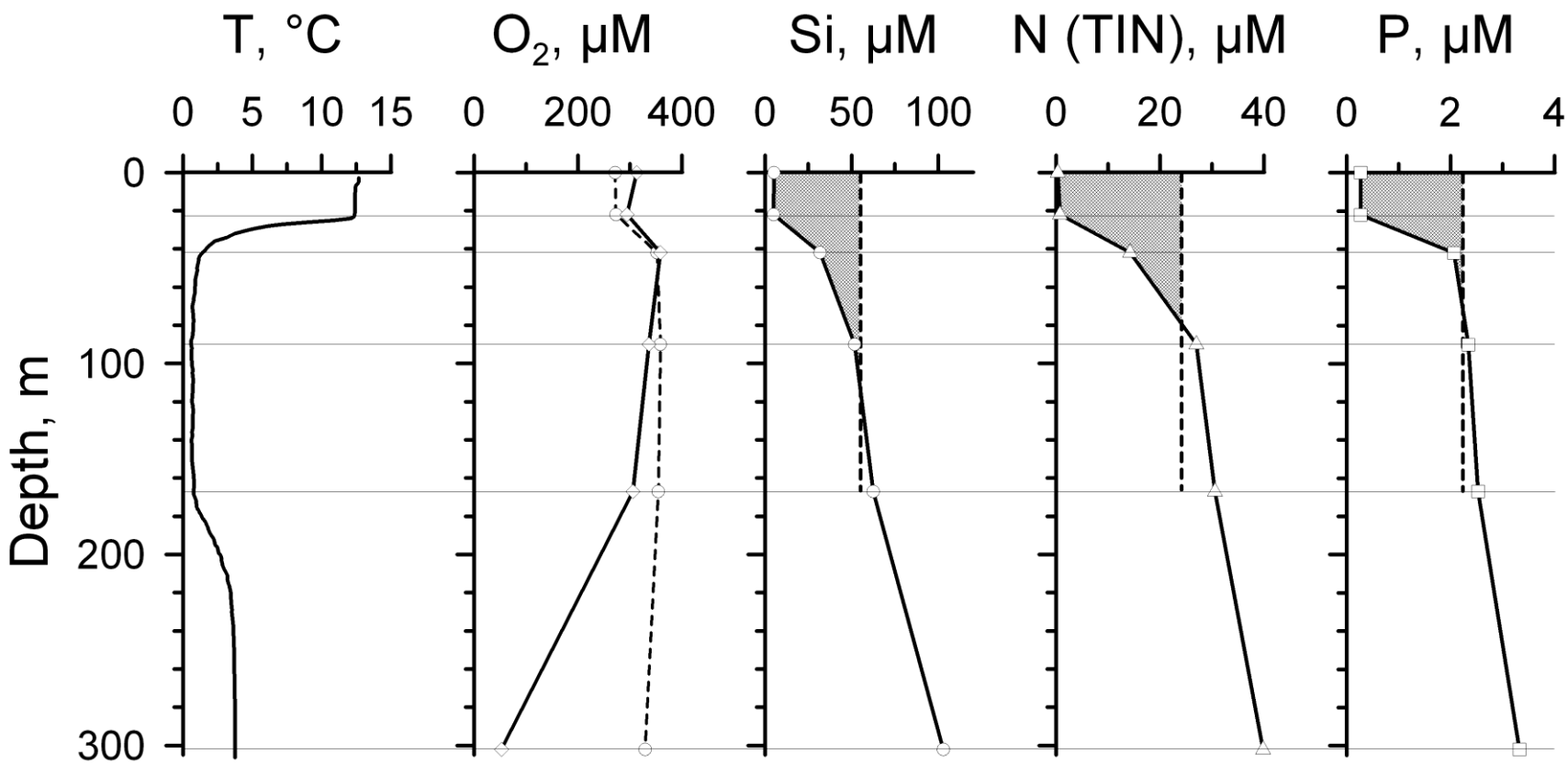
$N_{pre} = N_{obs} - N_{remin} \approx$ amount of N before active vegetation

Methods



Assumption: nutrient mineralization occurs in accordance to Redfield-Richards stoichiometry.
No advection!

Methods



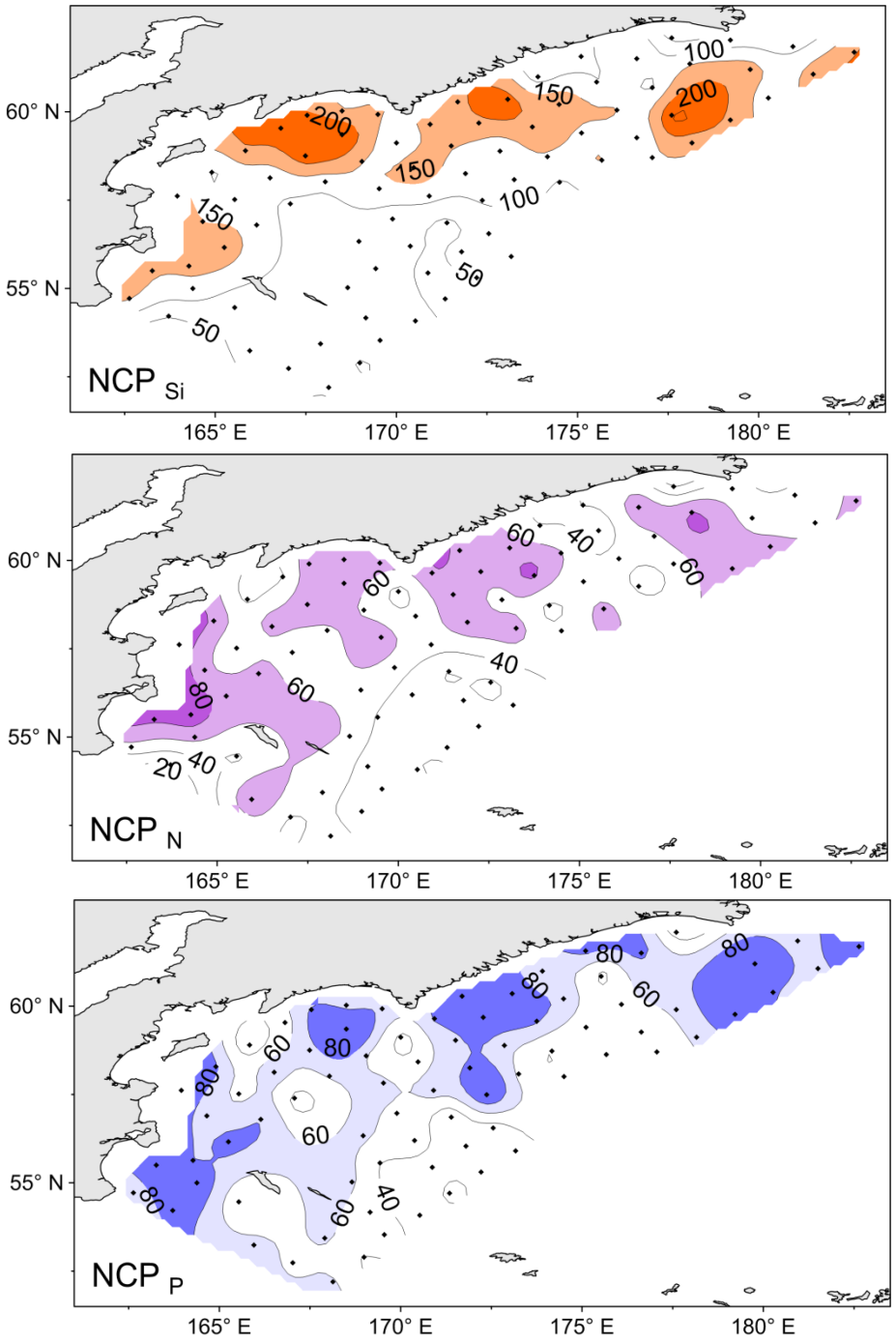
$$NCP_x = \left(\int [X_{pre}] - \int [X_{obs}] \right) \times K_x$$

Net community production

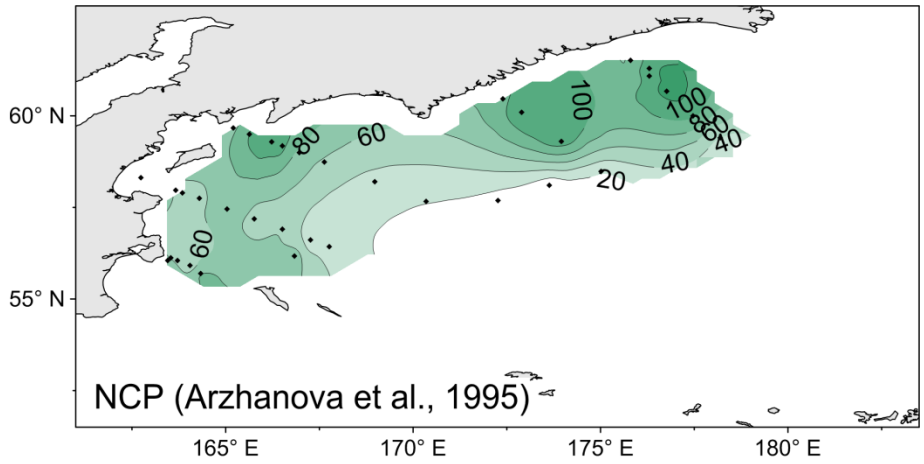
Coefficient, derived from Redfield-Richards ratio

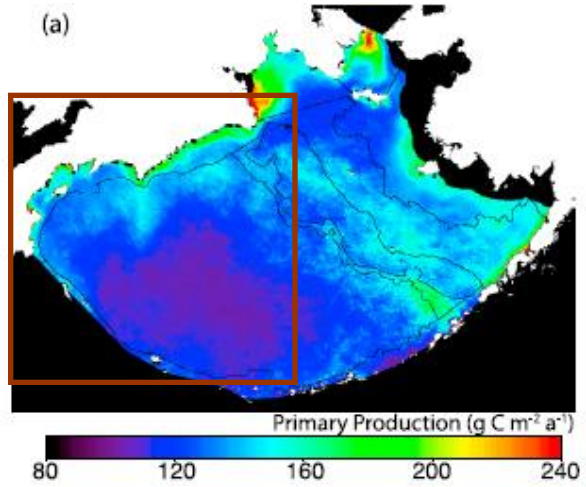
Mordy et al., 2012
Codicpoti et al., 2013

Results

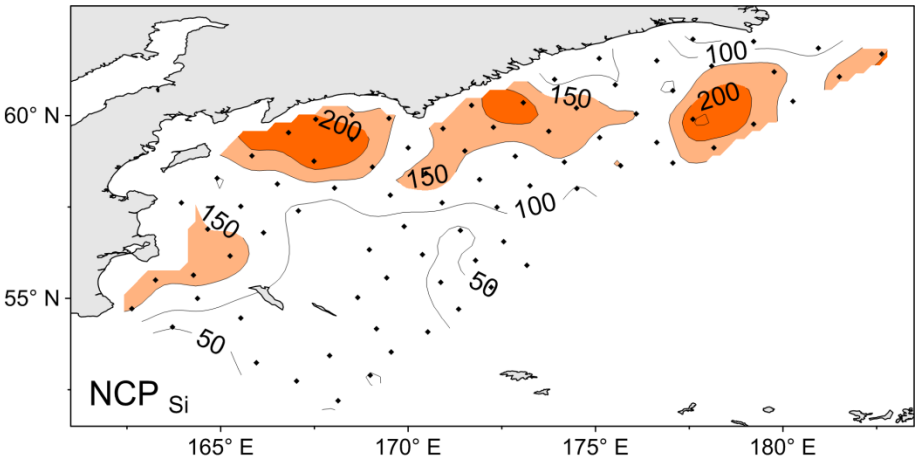

60° N
55° N
165° E
170° E
175° E
180° E
NCP Si
100
150
200
50
NCP N
20
40
60
80
NCP P

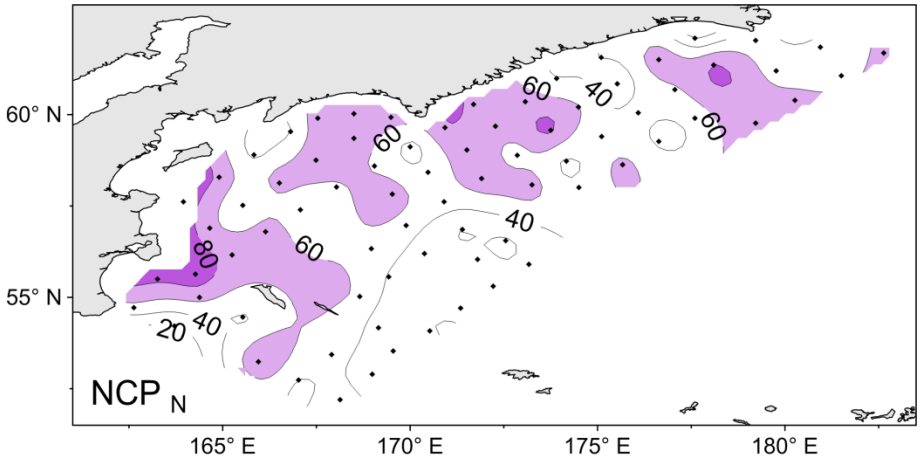
Results

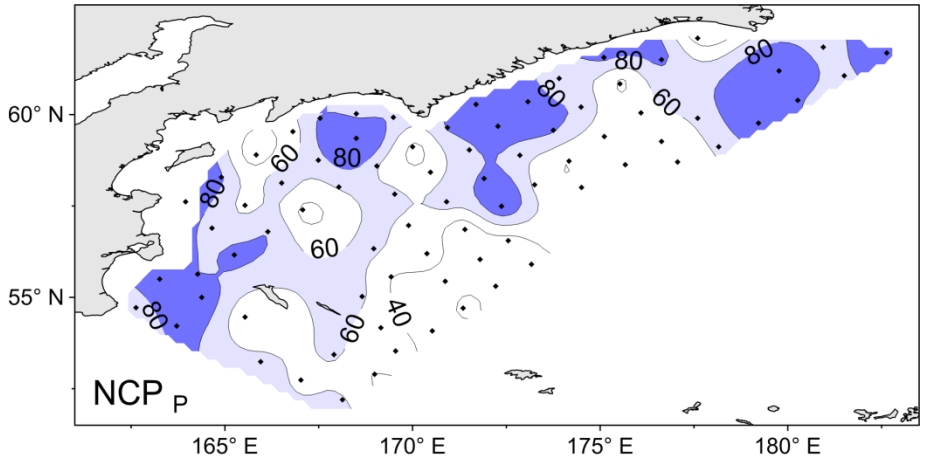




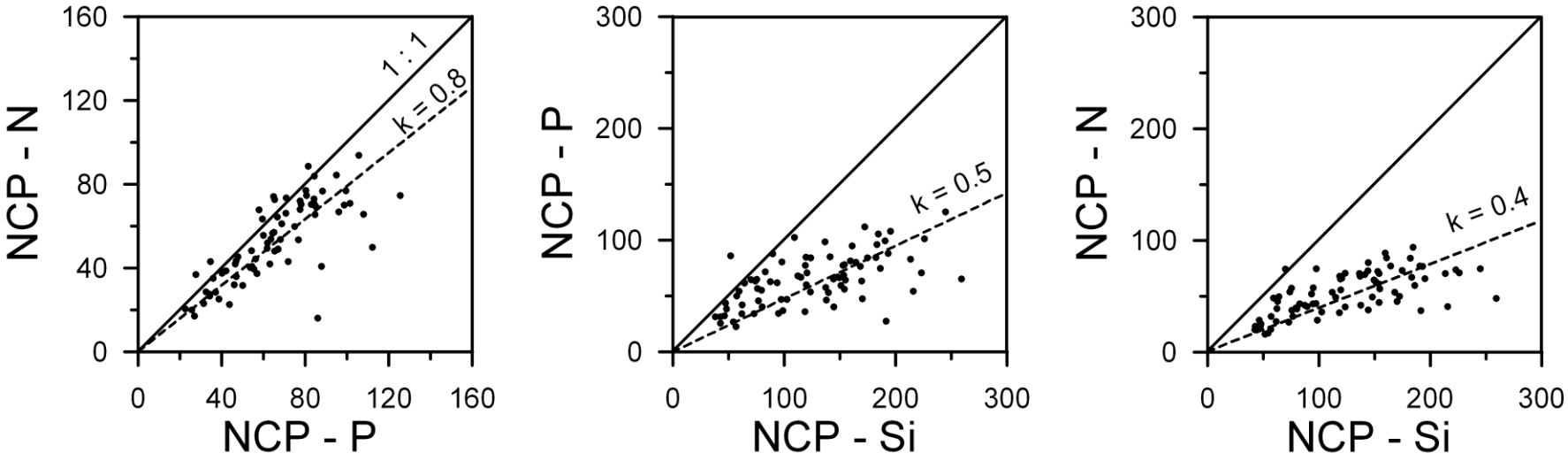
Primary production
Brown et al. (2013)







Results



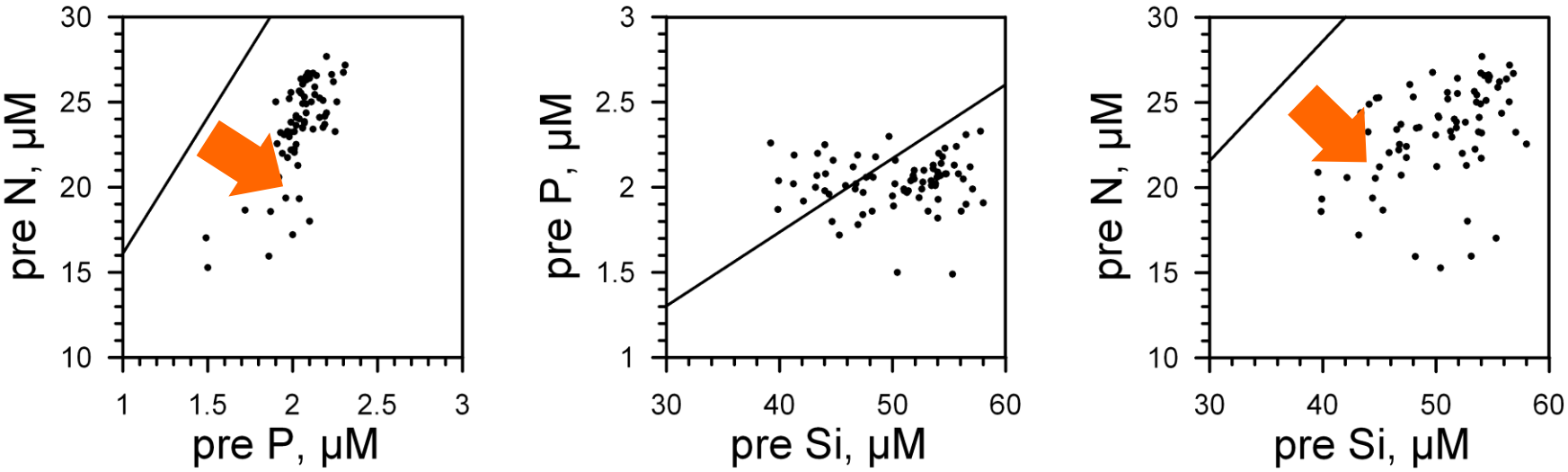
Scatters of calculated NCP-N and NCP-P, NCP-P and NCP-Si, and NCP-N and NCP-Si (g C m^{-2} yr^{-1}).

Diagonal solid lines denote 1:1 ratio.

Dashed lines denote linear regressions,
and approximate coefficients of regression are given.

Assuming Redfield-Richards stoichiometry of organic matter production and destruction,
≈ 20 % of new organic matter is produced under N deficit conditions while some winter P is still available.

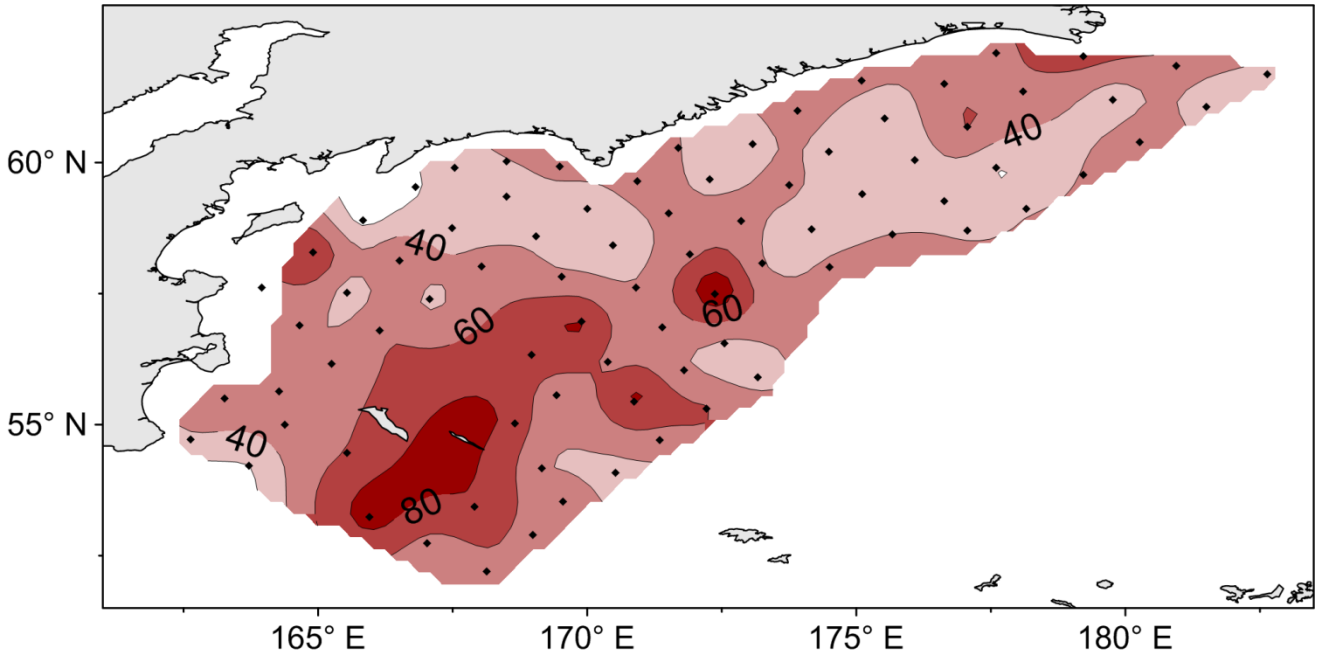
Results



Scatters of preformed N and P, P and Si, N and Si (µM).
Lines denote Si / N / P ratio of 23 / 16 / 1.

Assuming nutrient consumption by phytoplankton with ratio of
Si / N / P = 23 / 16 / 1,
one may see that primary productivity is potentially limited by nitrogen.

Results



Ratio of NCP-N (proxy for “new” PP) and NCP-Si (proxy for “total” PP), %.

Discussion

$C_{106}H_{175}O_{42}N_{16}P + 118\ O_2 \rightarrow 106\ CO_2 + 16\ NH_4 + HPO_4^{2-} + 48\ H_2O + 14\ OH^-$

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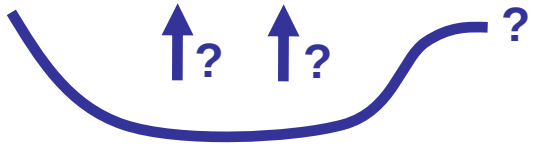


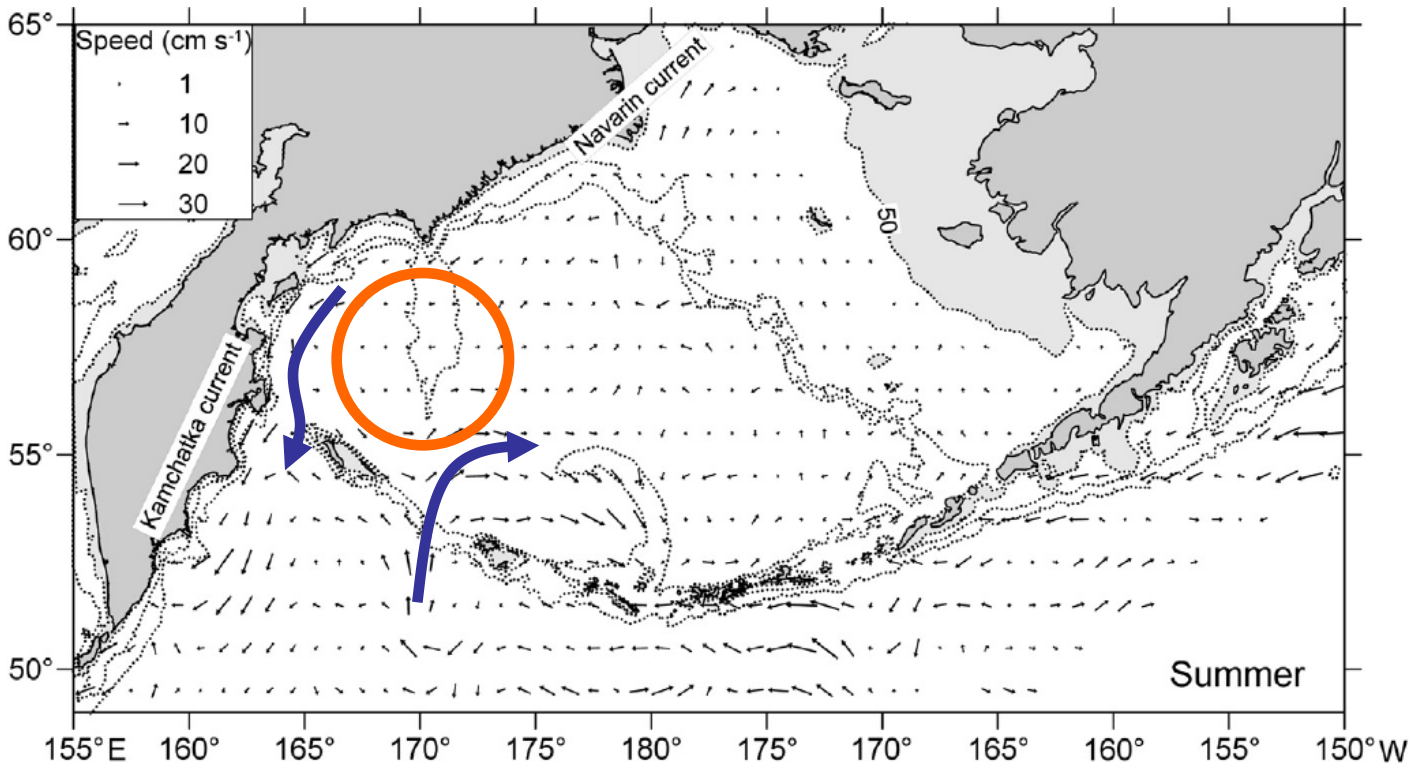
Wang et al. (2002 a) reported ΔDIC / Δ N for central and south-eastern Bering Sea to be in a range of **6.58** and **6.17**, resp. (instead of Redfield's 6.62).

Wang et al. (2002 b) reported ΔDIC / Δ Si / Δ N / Δ P ≈ **101 / 36 / 18 / 1**

According to Martiny et al. (2013) may be C / N / P ≈ **50-150 / 10 / 1** in the eastern Bering Sea.

Also average new production was reported to be
≈ 41.1 g C m-2 yr-1 for central Bering
≈ 61.7 g C m-2 yr-1 for south-eastern Bering Sea
(Wong et al. 2002 a)

Discussion



Average currents at 40 m derived from ECO-FOCI drifter data for summer

Calculations of NCP may be affected by advection on the periphery of study area.

Khen et al., 2013

Conclusions

- Net community production in the Bering Sea is estimated to be in range of 50-250 g C m^{-2} yr^{-1}
- New to total PP ratio was estimated to be in range of 0.2-0.8
- Generally received results correspond well with existing data and estimations
- Results may be affected by ignorance of local C / O_2 / Si / N / P stoichiometry, or / and advection

Thank you for attention!

관심을 가져 주셔서 감사