Evidence of local upwellings

in the north-western Bering Sea in 2012

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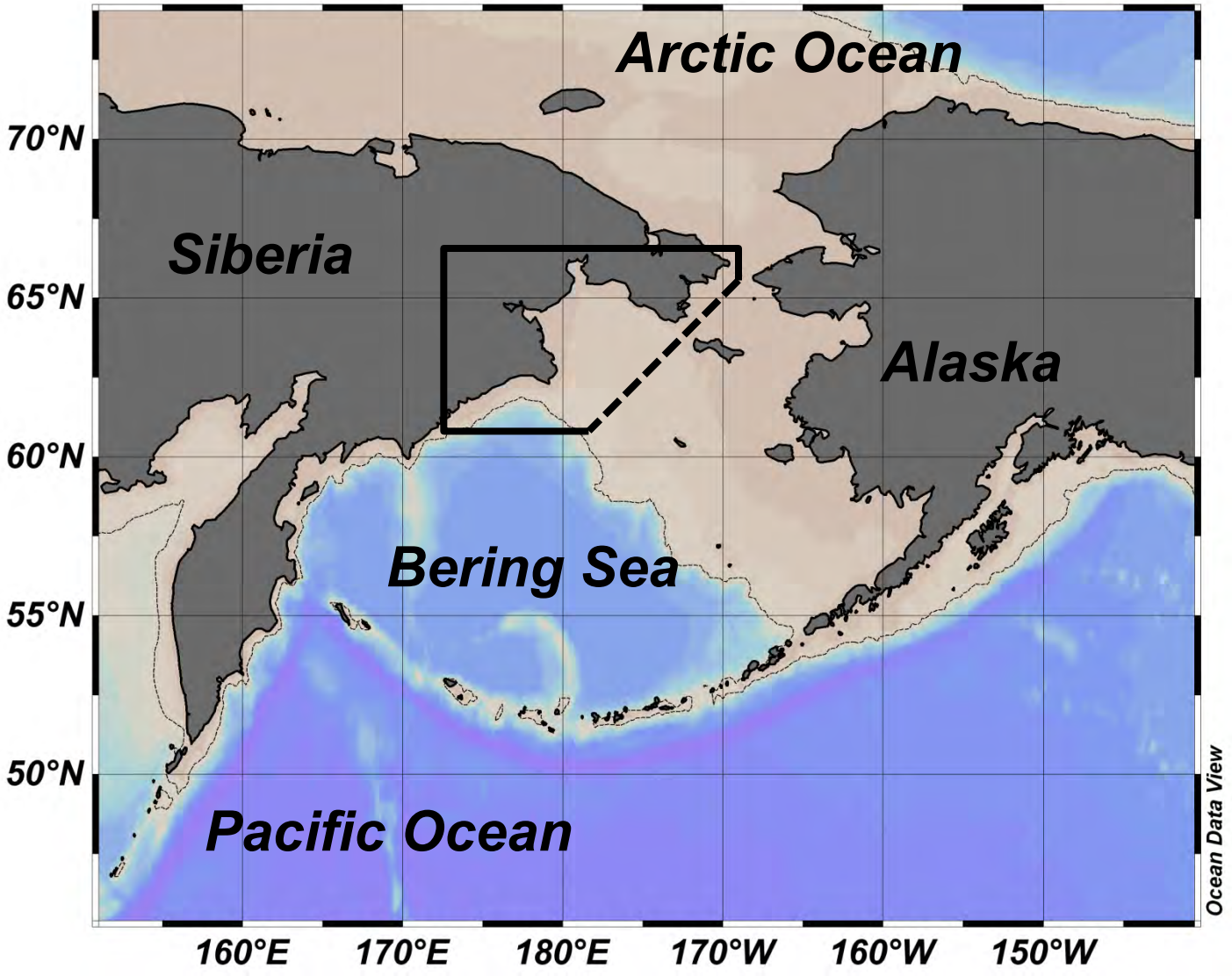
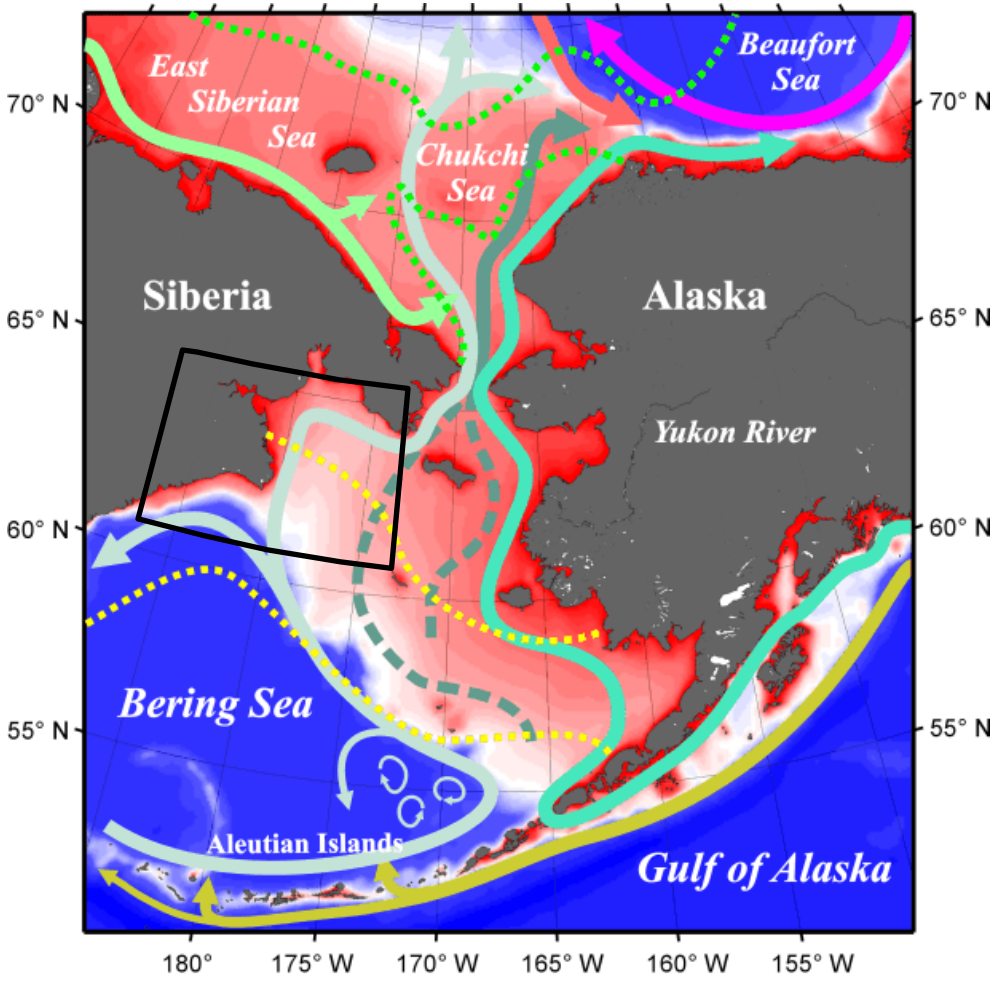
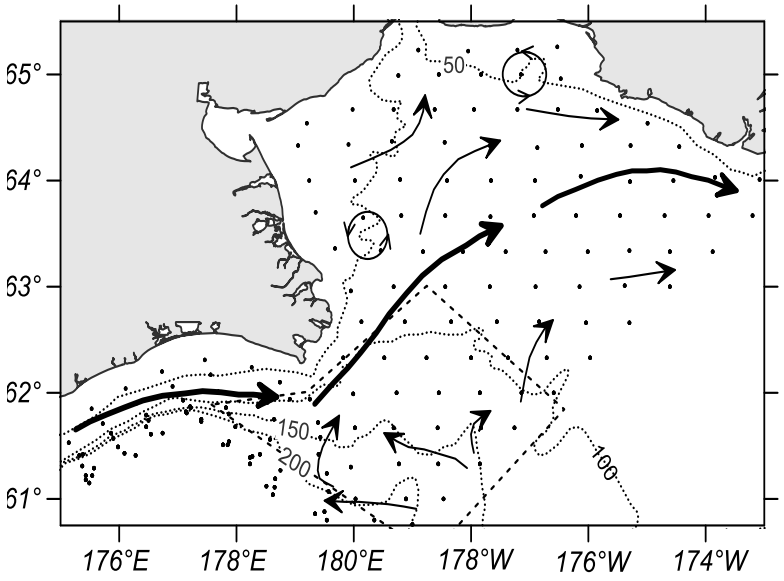
Introduction



Introduction

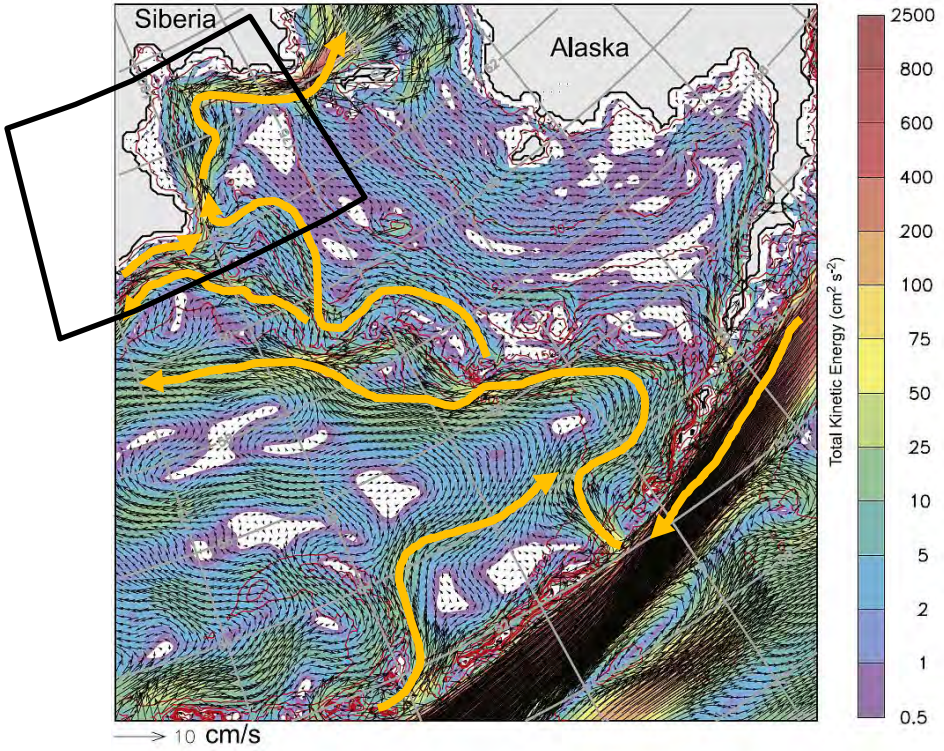


Scheme of the Bering Sea circulation
(Curchister 2010)

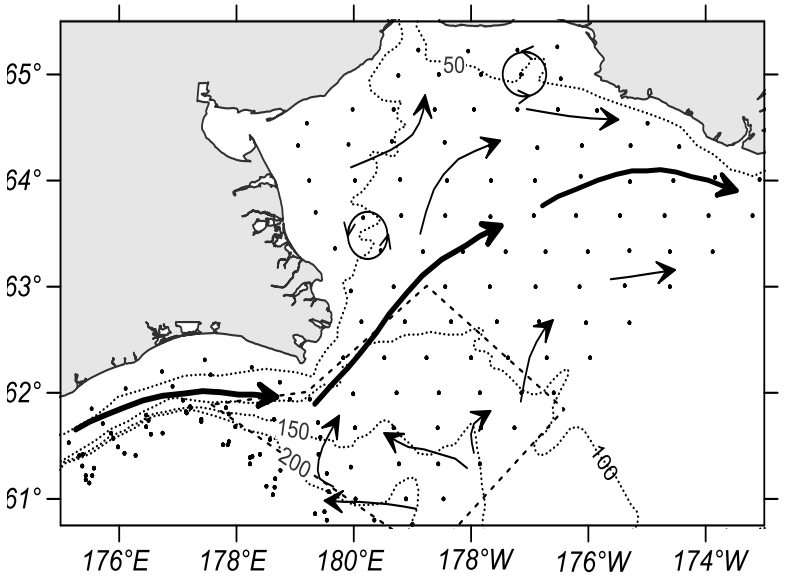


Geostrophic flows in July-August 2012
Bold lines represent flows > 5 m sec^{-1}
(Basuk et al. 2012)

Introduction



1979–2004 mean 0–220m circulation and total kinetic energy (Kinney et al. 2009)



Geostrophic flows in July-August 2012
Bold lines represent flows > 5 m sec^{-1}
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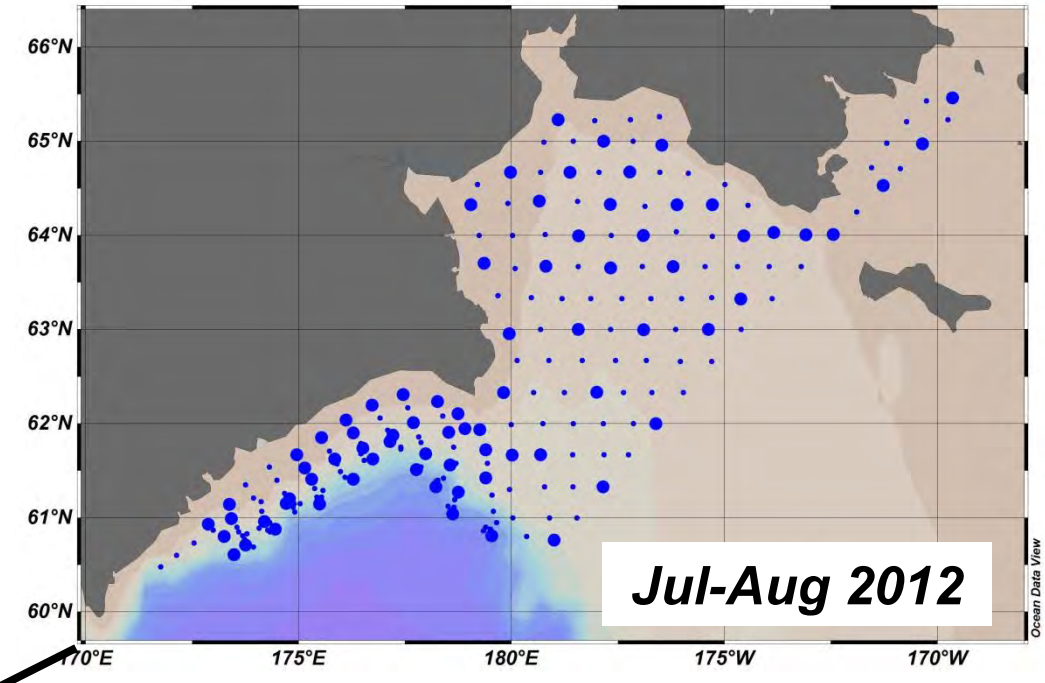
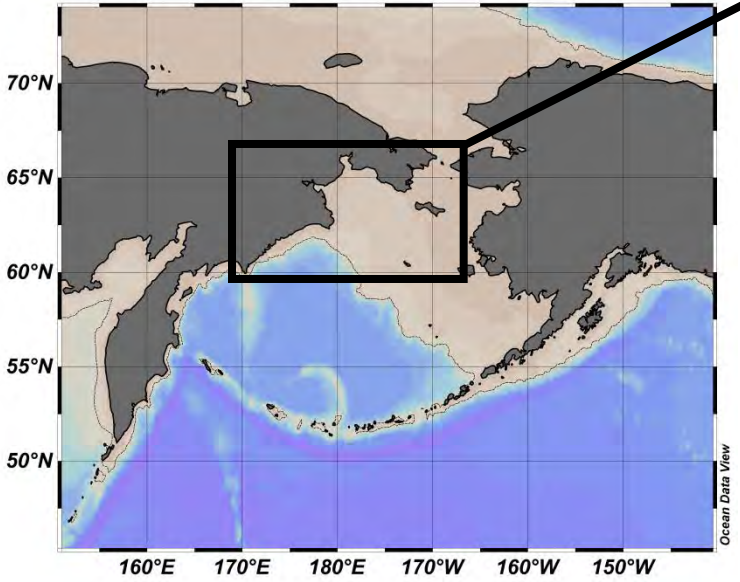
The Area

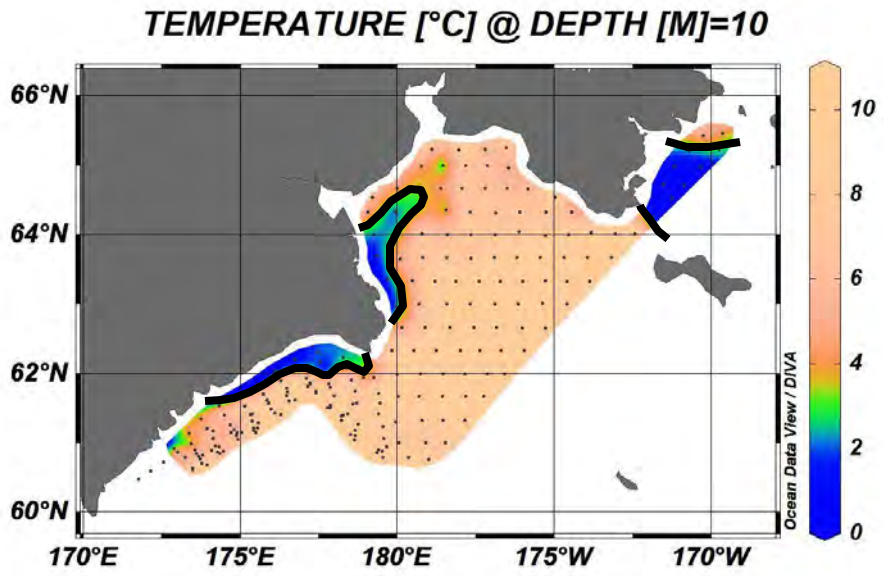

66°N
65°N
64°N
63°N
62°N
61°N
60°N
170°E
175°E
180°E
175°W
170°W
Jul-Aug 2012
Ocean Data View

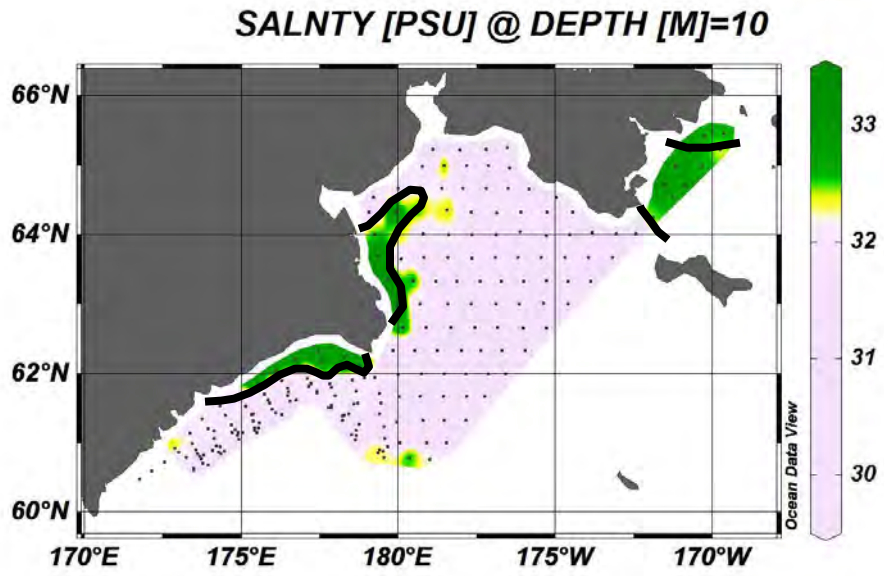

70°N
65°N
60°N
55°N
50°N
160°E
170°E
180°E
170°W
160°W
150°W
Ocean Data View

Methods

- Survey aboard Fisheries R/V “Professor Kaganovsky” (TINRO-Center)
  - ***218 CTD stations***: SBE 9 plus Sealogger
  - ***80 sampling stations***: O_2, SiO_3^{2-}, PO_4^{3-}, NO_2^-, NO_3^-, NH_4^+
  - additional samplings : Surface NPP, TON, TOP

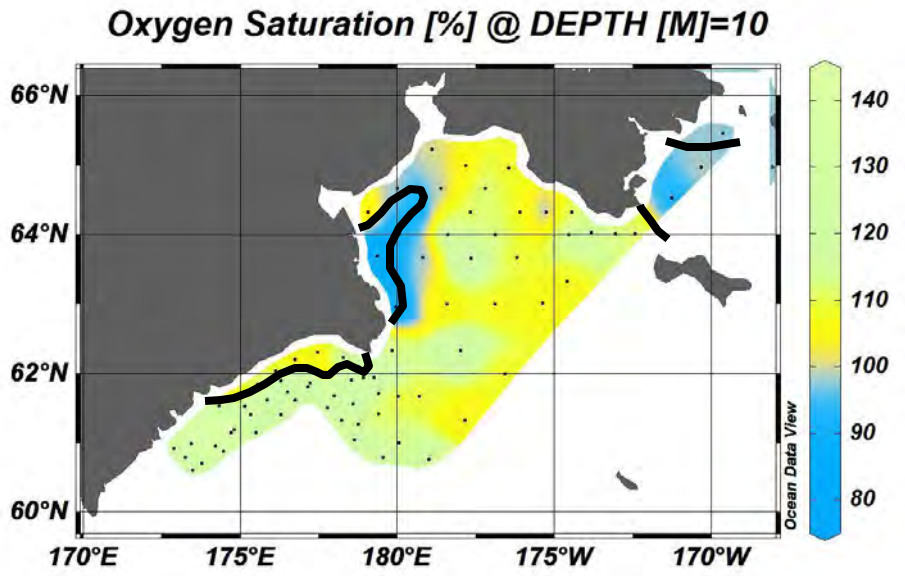
Results

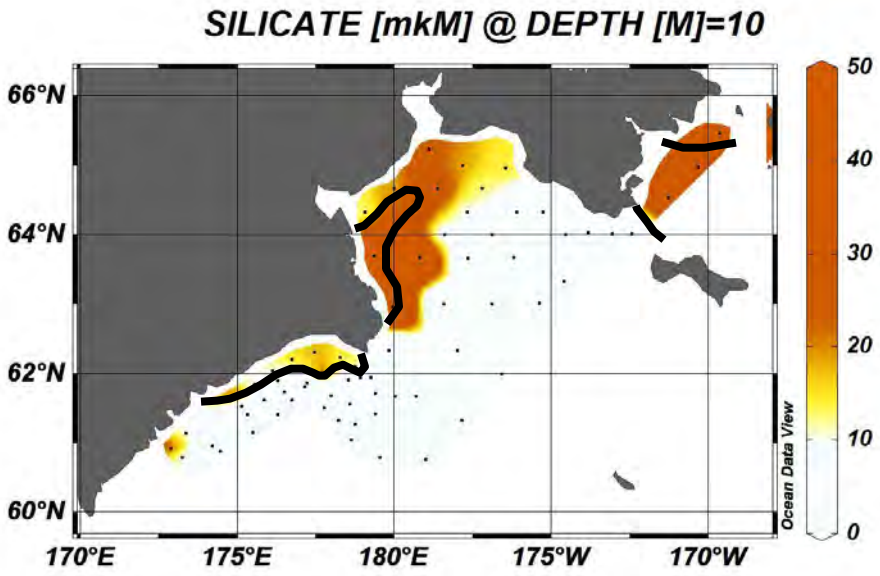


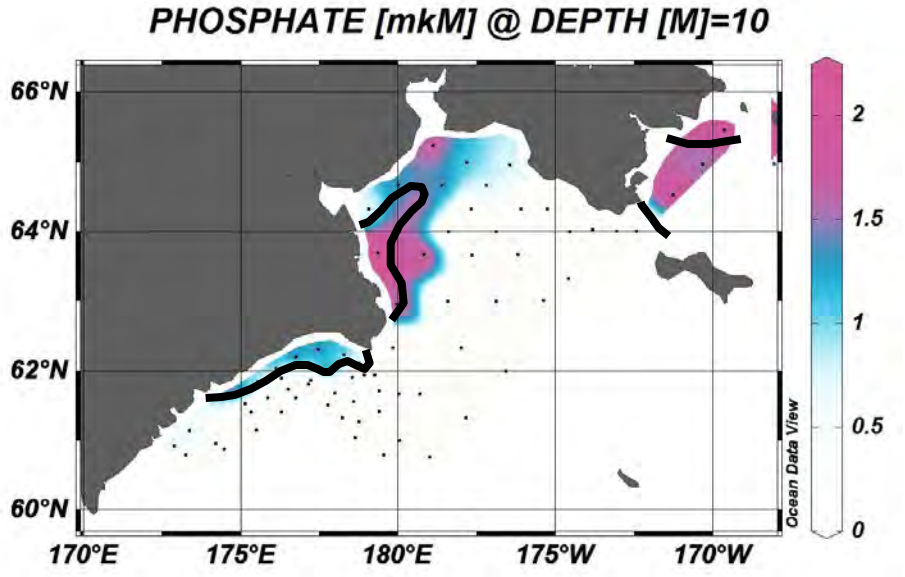


- Low temperatures and high salinity along Koryak coast, west Gulf of Anadyr, and Chirikov Basin
- Temperature fronts of with $\nabla T \approx 3^{\circ}C$

Results

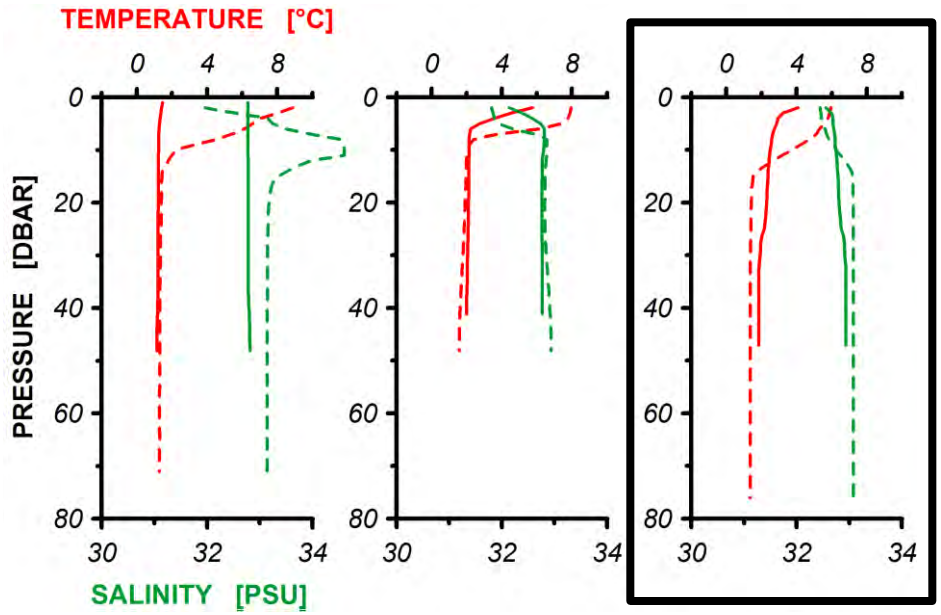


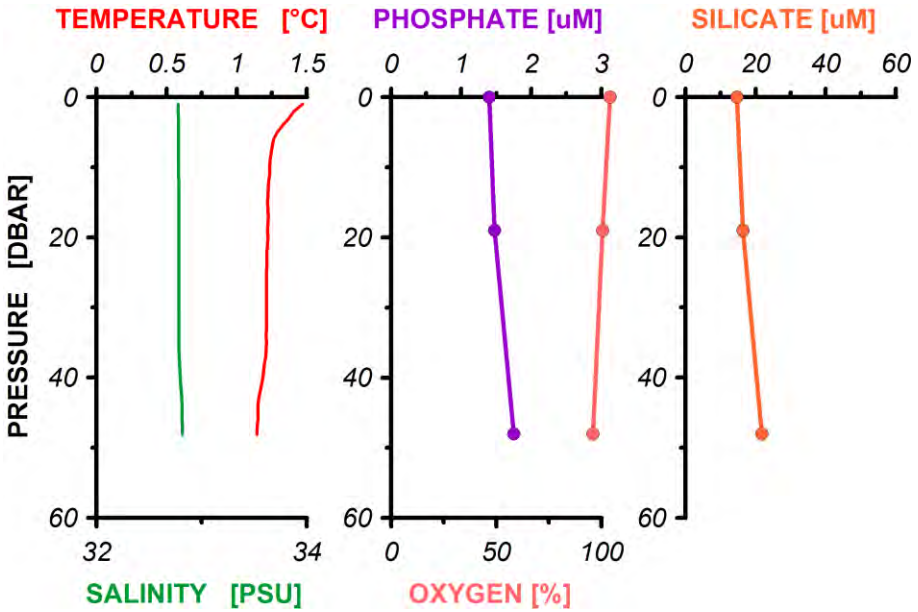


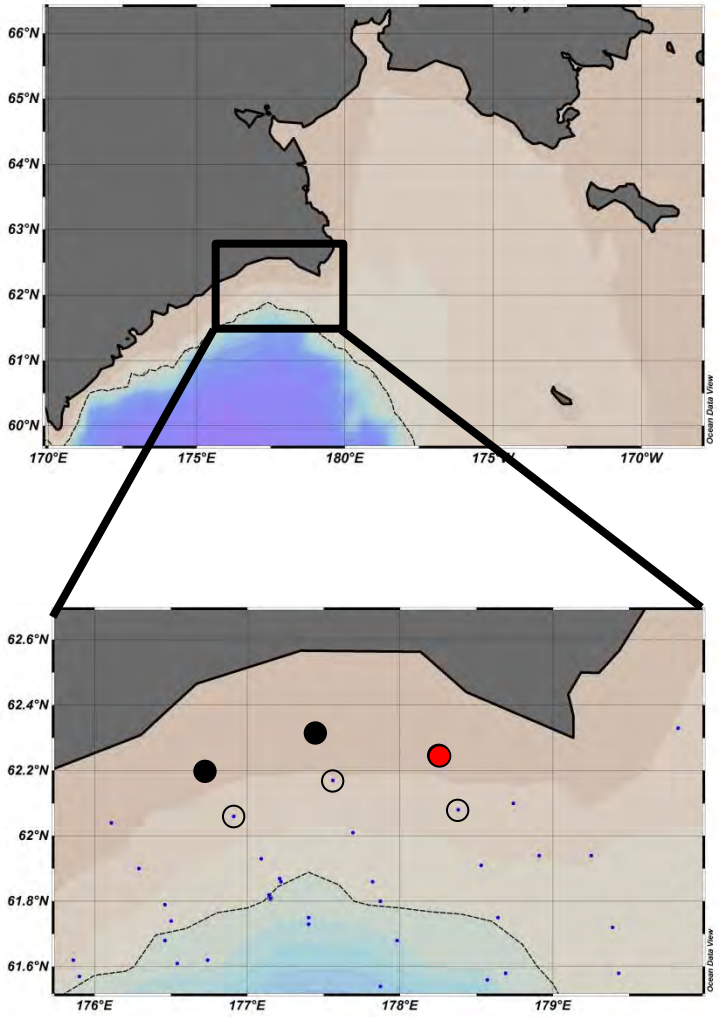


- Features of nutrient fields, and O_2 match physical features
- > 100 % oxygen saturation on the Koryak shelf => intensive PP

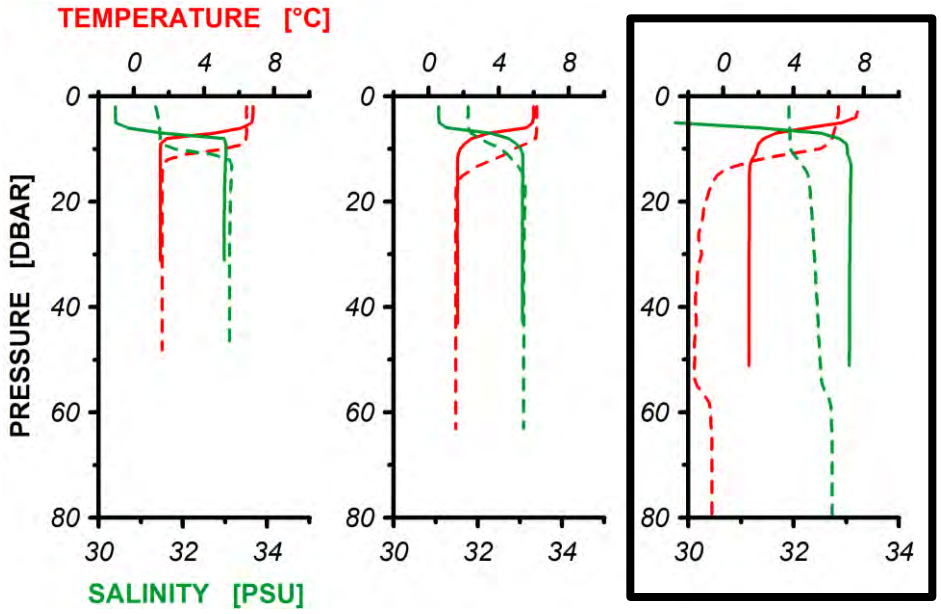
Results: Koryak upwelling

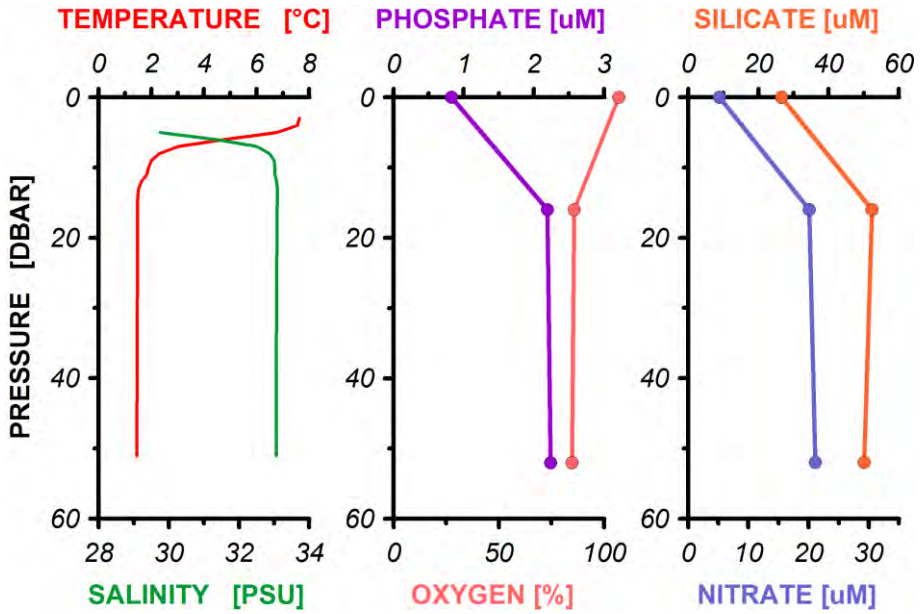


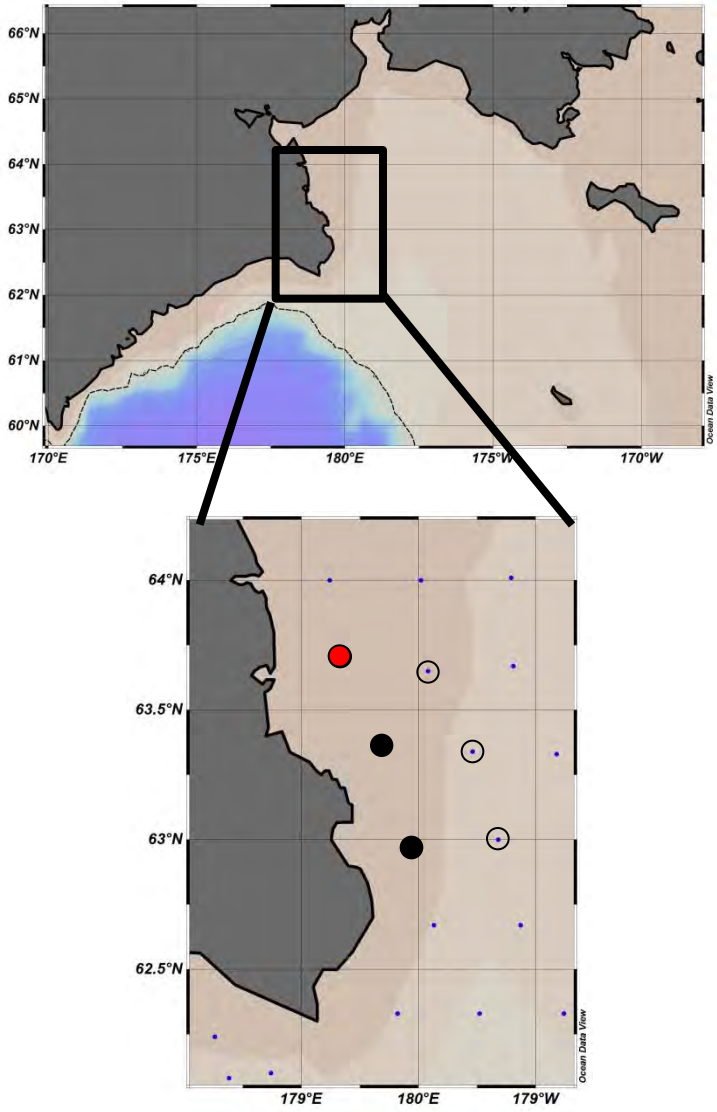




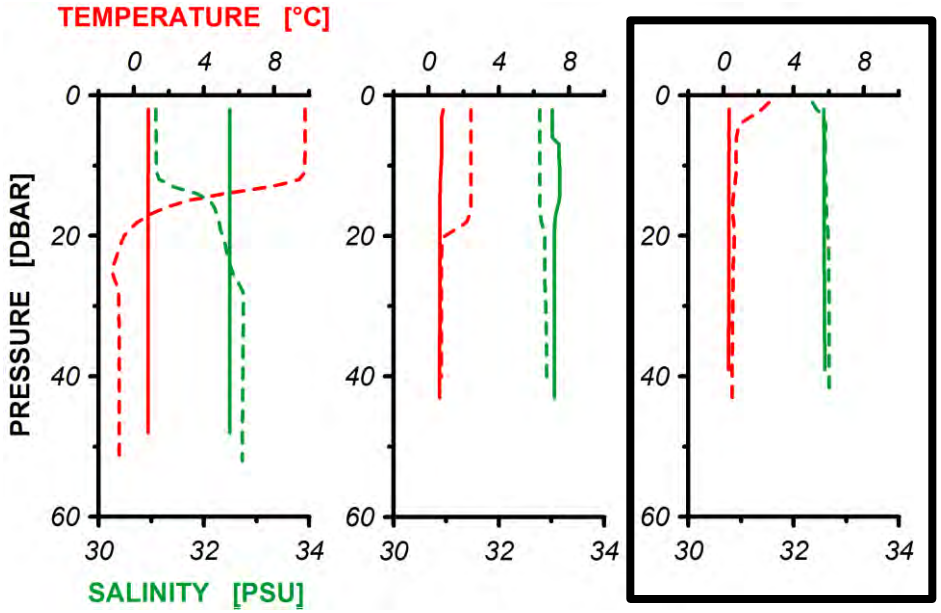
Results: West Anadyr upwelling

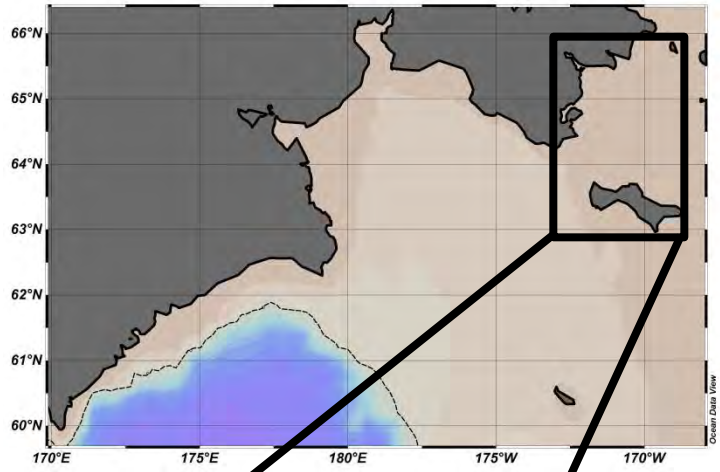


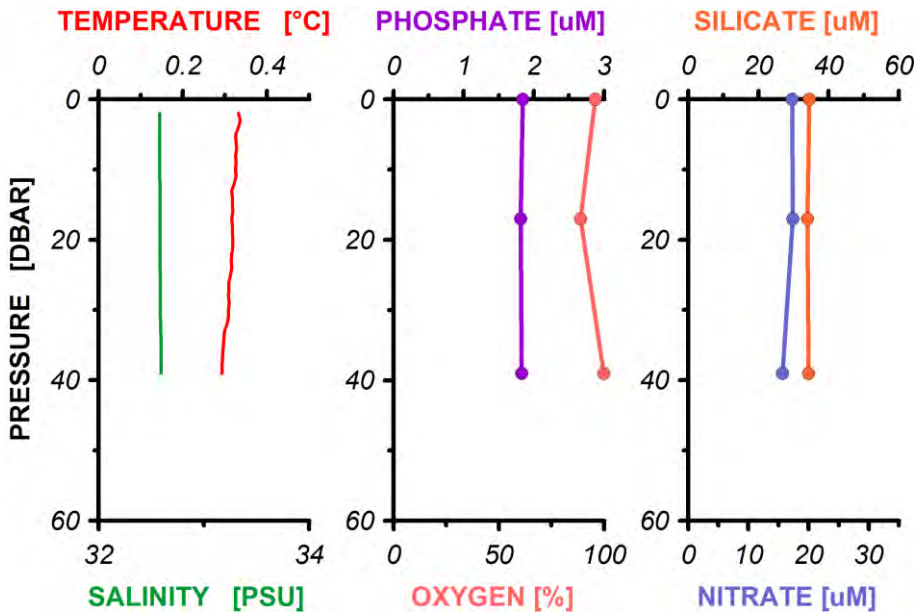


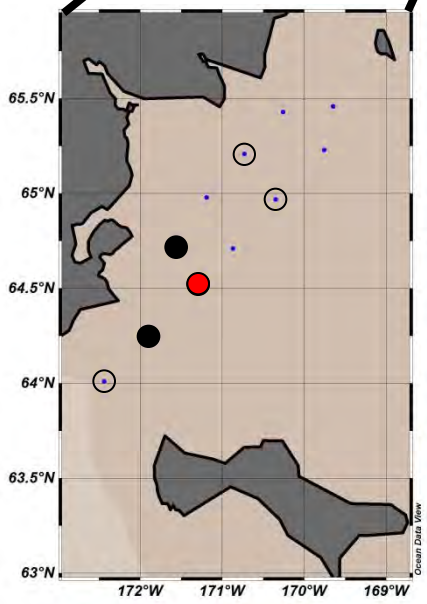


Results: Chirikov Basin upwelling

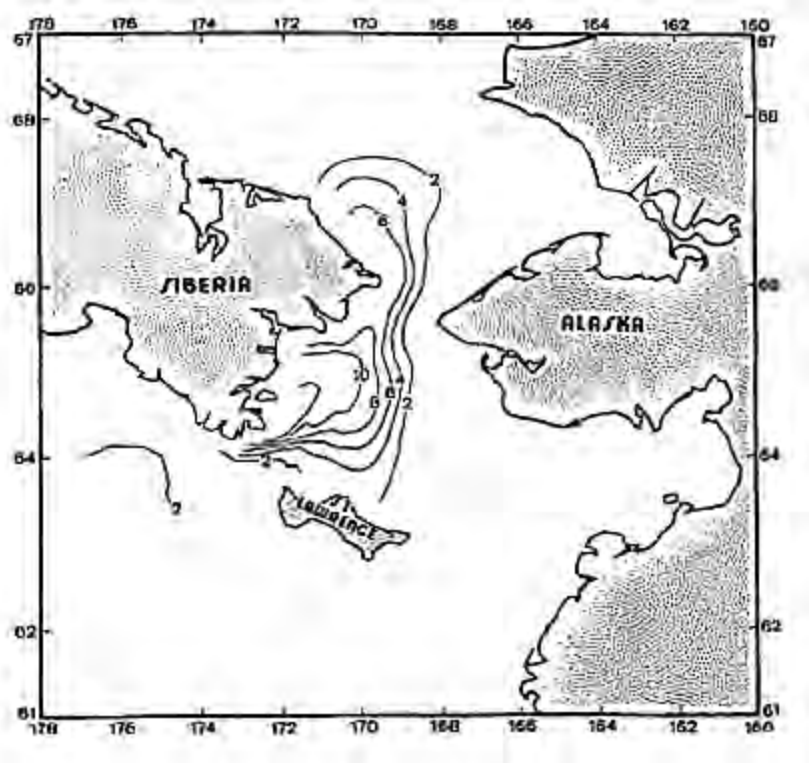




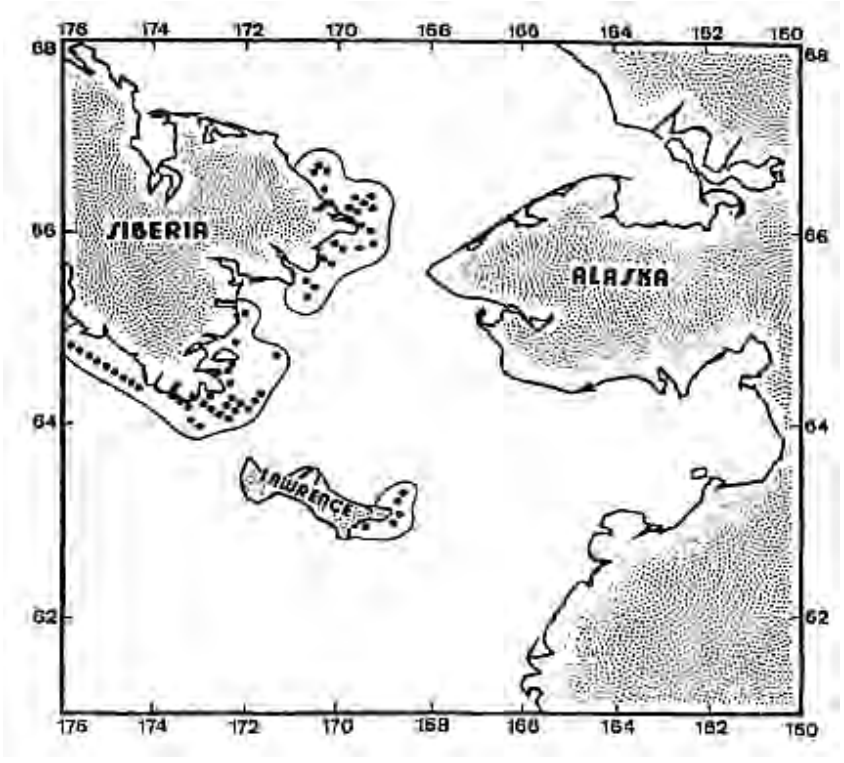




Discussion



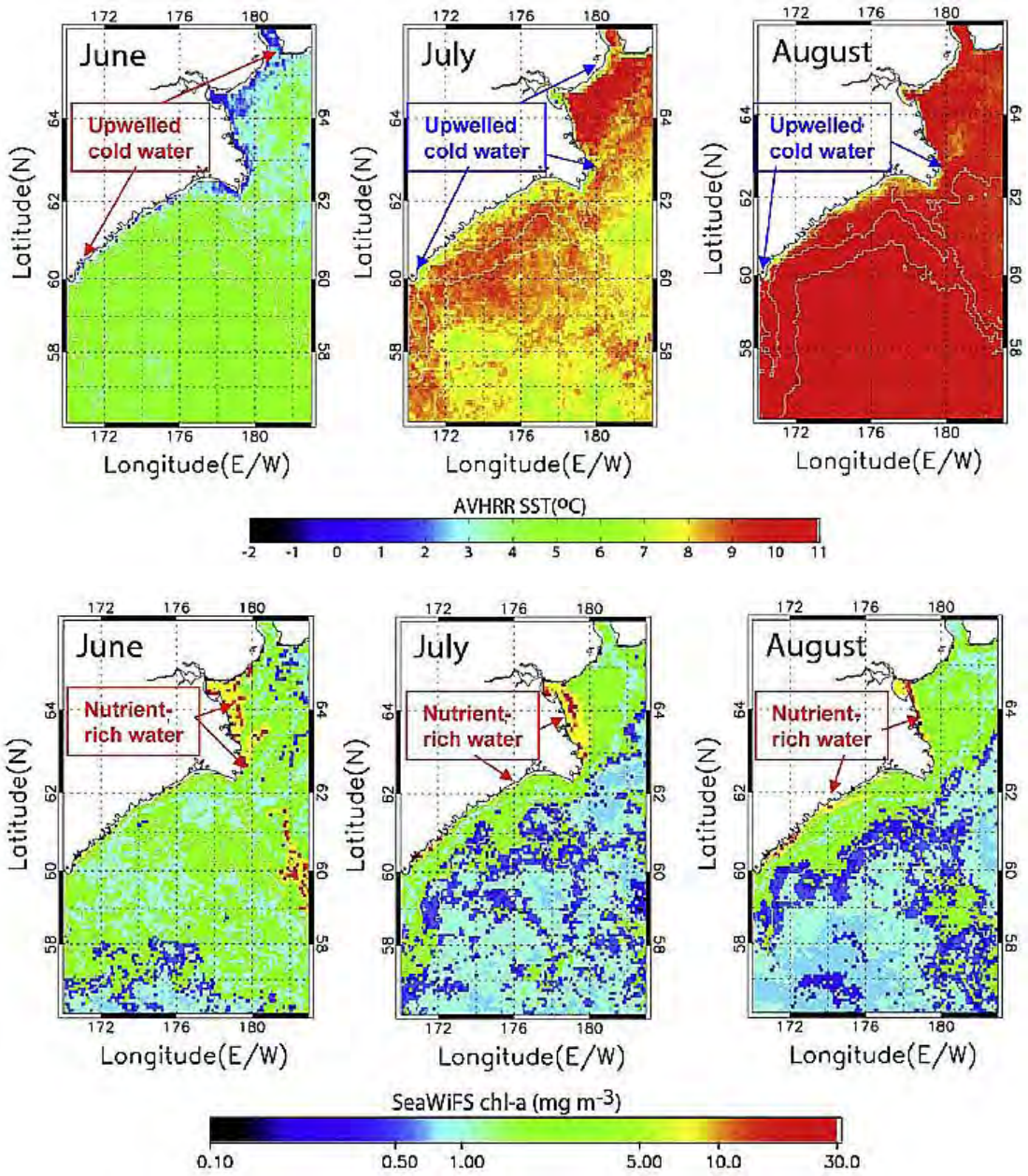
Sea surface distribution of nitrate (reference summer situation).



Upwelling/upsloping along the siberian coast. Grid points with vertical velocity of **>4 m day^{-1}** are indicated.

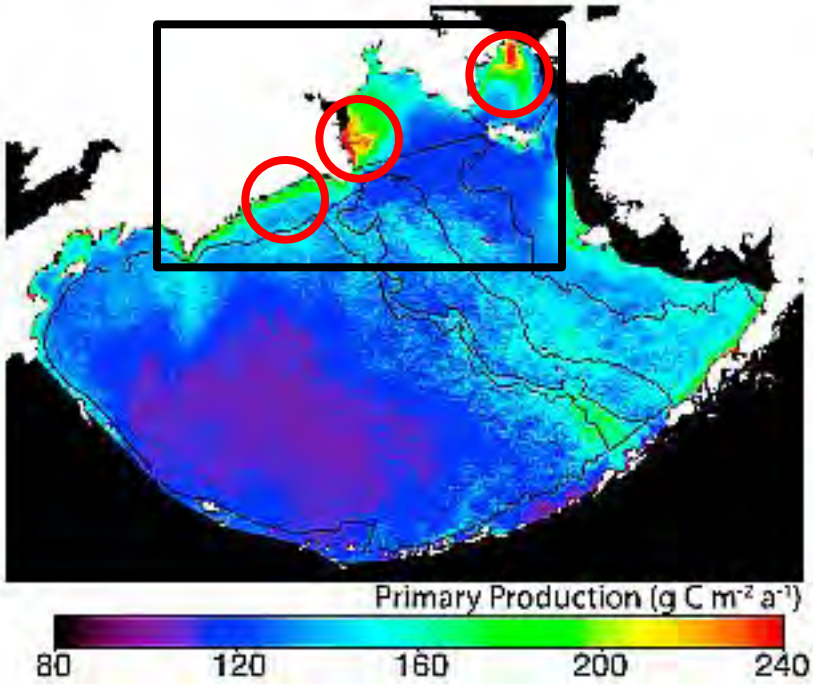
(Nihoul et al. 1993)

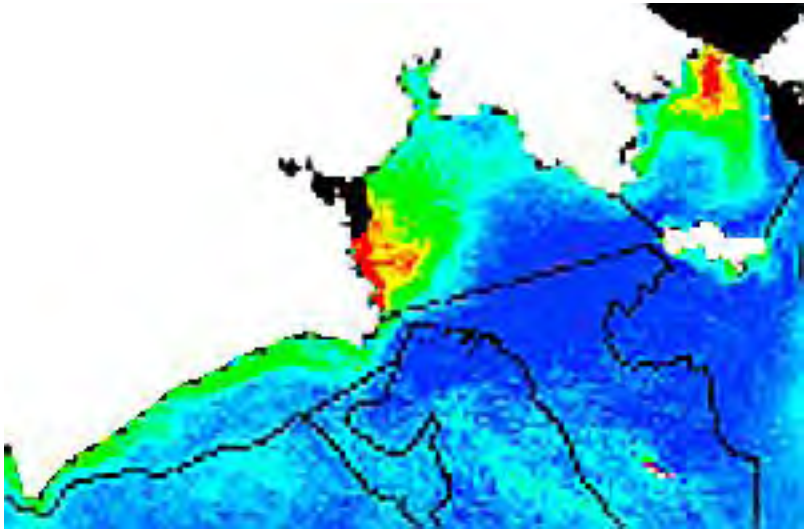
Discussion



The (top) 4-km AVHRR-measured SST climatology and (bottom) 10-km SeaWiFS measured chlorophyll-a climatology in June, July, and August averaged from 1996 to 2006.
(Wang et al. 2009).

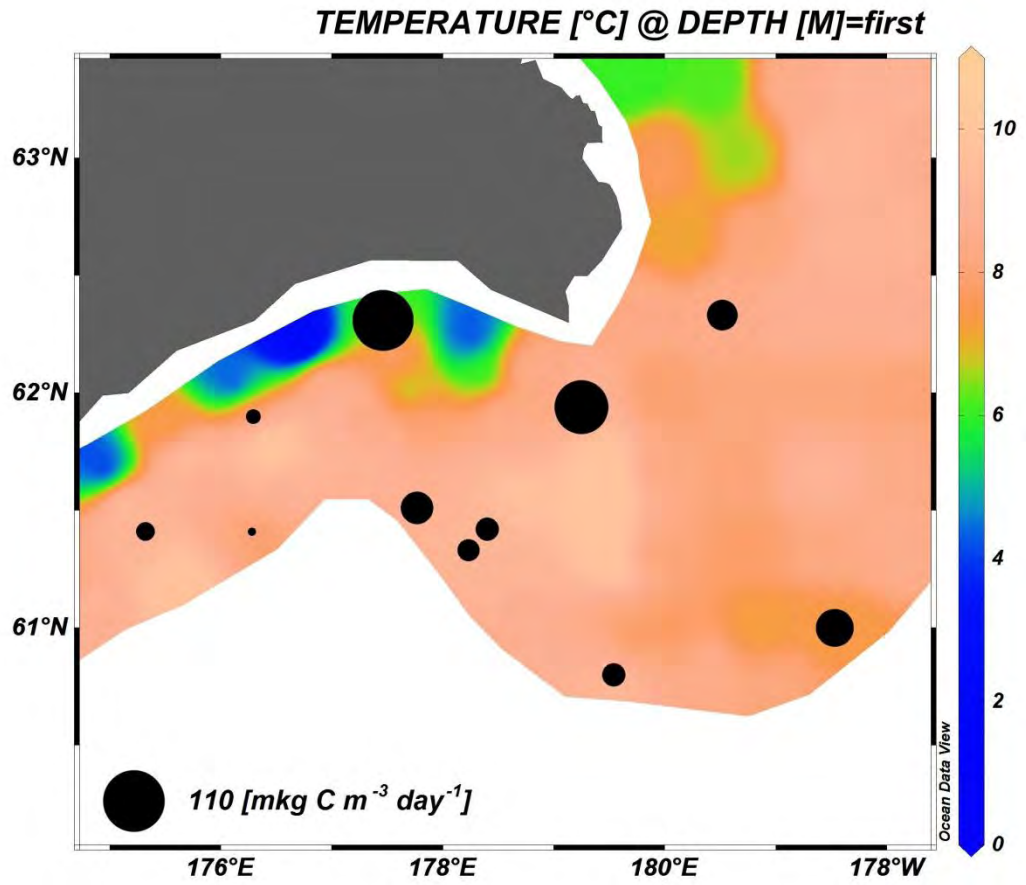
Discussion





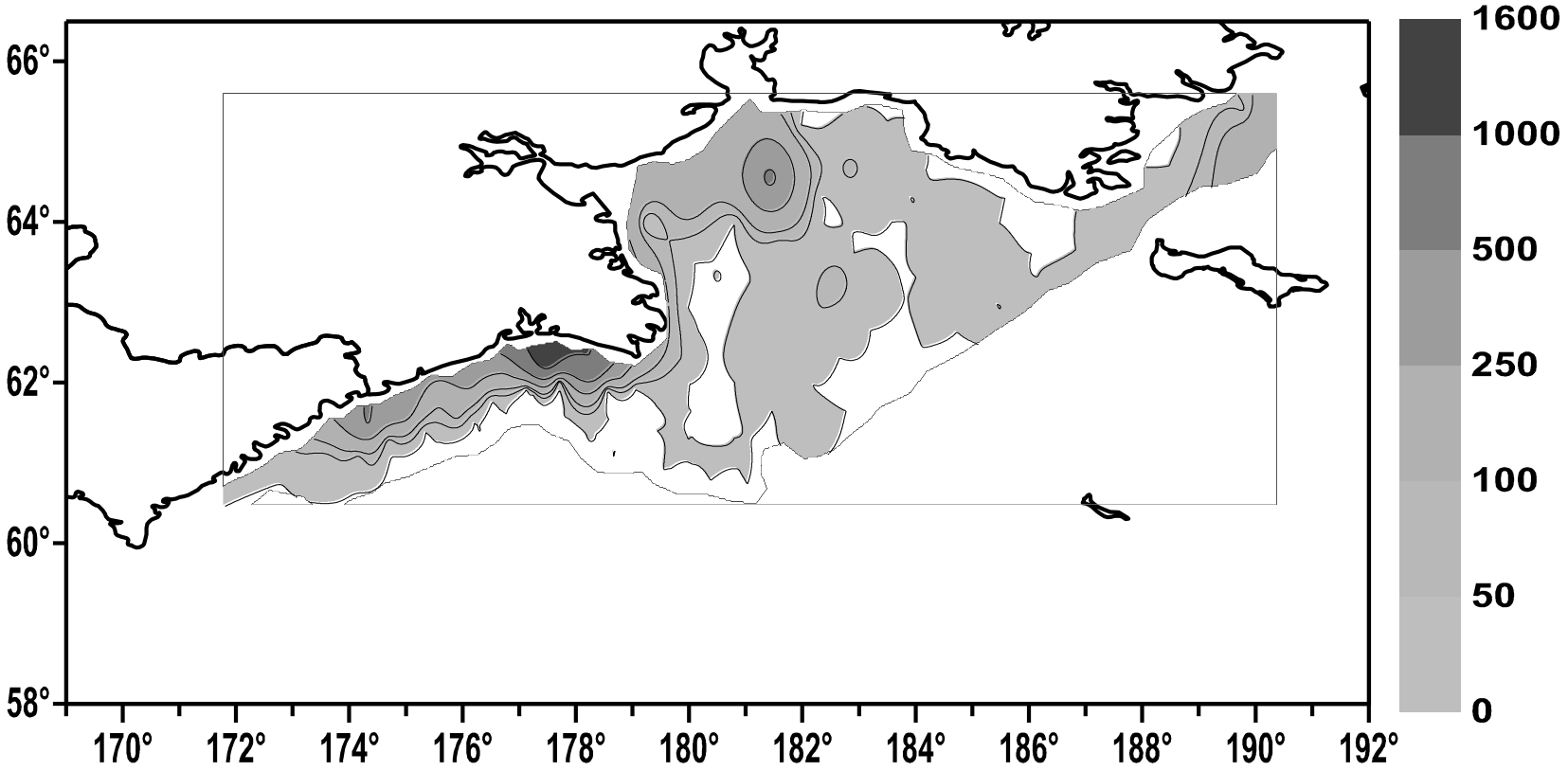
Climatologies of primary production in the Bering Sea for 1998–2007 showing annual area-normalized NPP (g C m^{-2} yr^{-1}) (left panel), and the date of the spring phytoplankton bloom, taken as the date of maximum daily NPP in spring (right panel).
(Brown et al. 2011).

Discussion



Sea surface temperature [°C]
overlaid by surface **net primary production** [mkg C m^{-3} day^{-1}]
July 2012

Discussion



Large (> 168 μm) phytoplankton biomass in 0-200 m or 0-bottom layer, [mg m^{-3}] (courtesy of Loseva O.E.)

Discussion

Estimation of NPP associated with local upwellings in the north-western Bering Sea

	$P\text{-}PO_4^{3-}$ [mol m^{-3}]	W [m day^{-1}]
Koryak Shelf	1.5	2
Gulf of Anadyr	2.0	2
Chirikov Basin	2.0	4

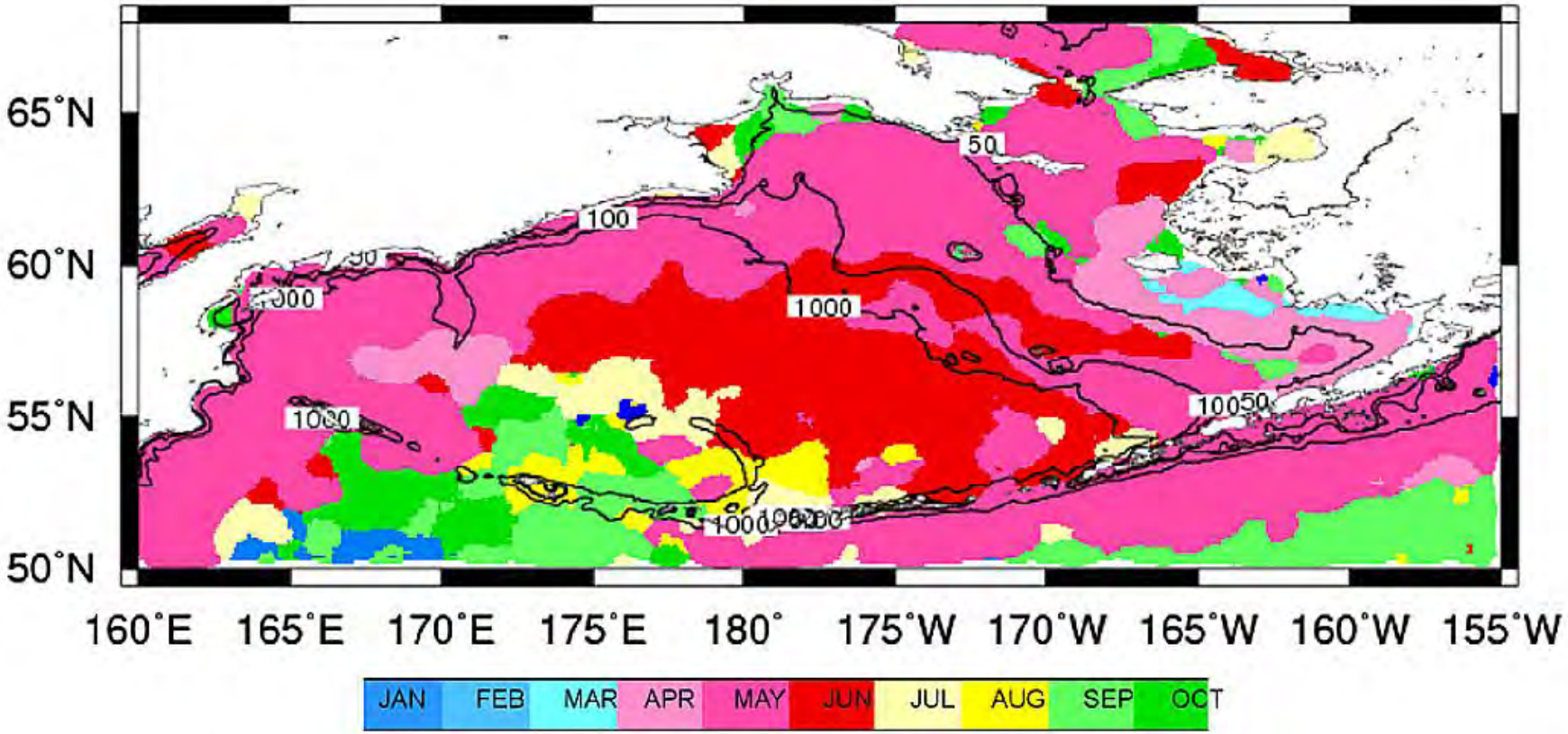
Conclusions

- Two upwellings are clearly indicated from CTD and nutrient data from July-August of 2012: **Koryak coastal upwelling, and Chirikov Basin upwelling**

- Upwelling-like coastal feature was also observed in the **western Gulf of Anadyr**

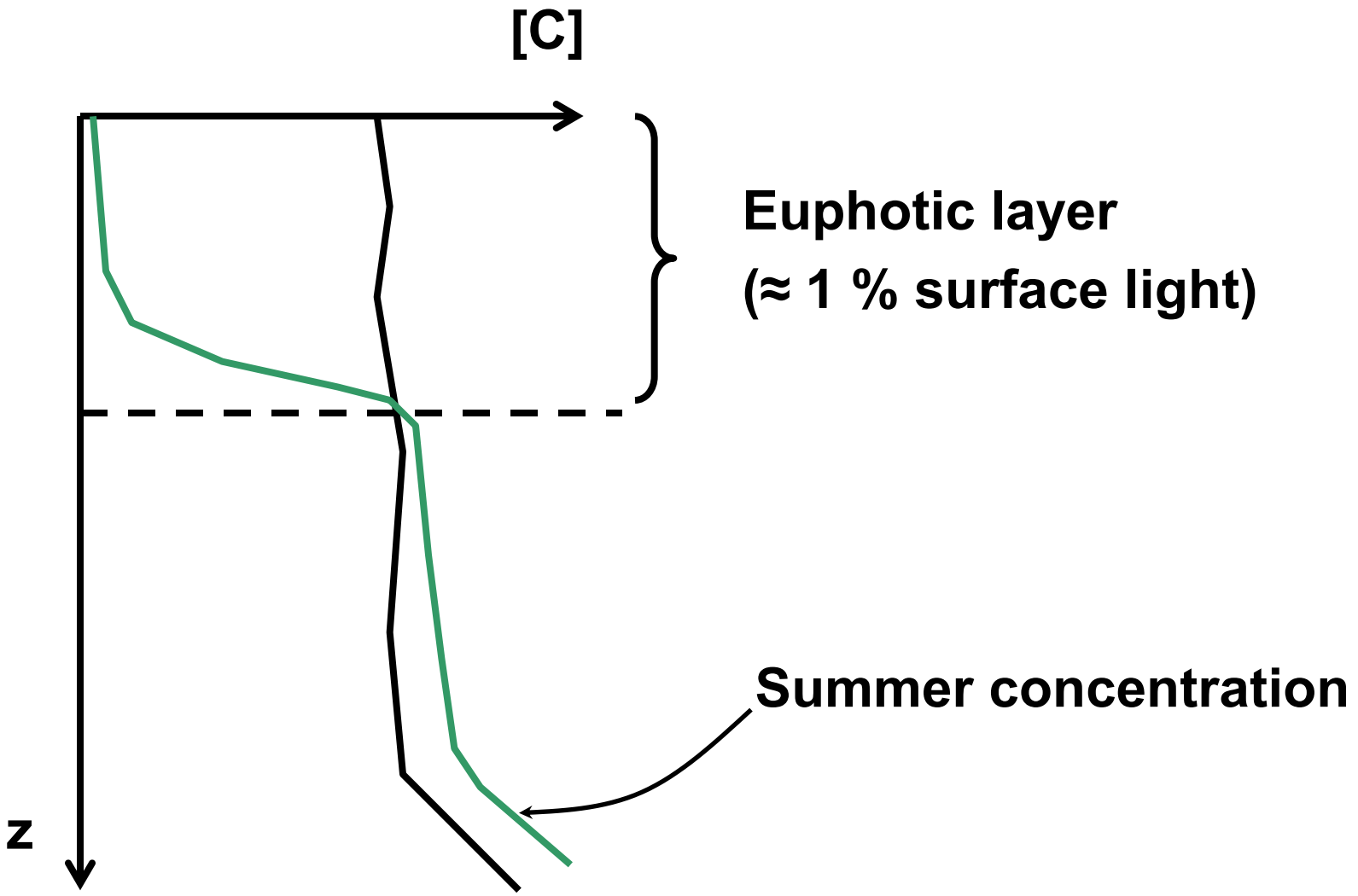
Thank you for attention!

Discussion

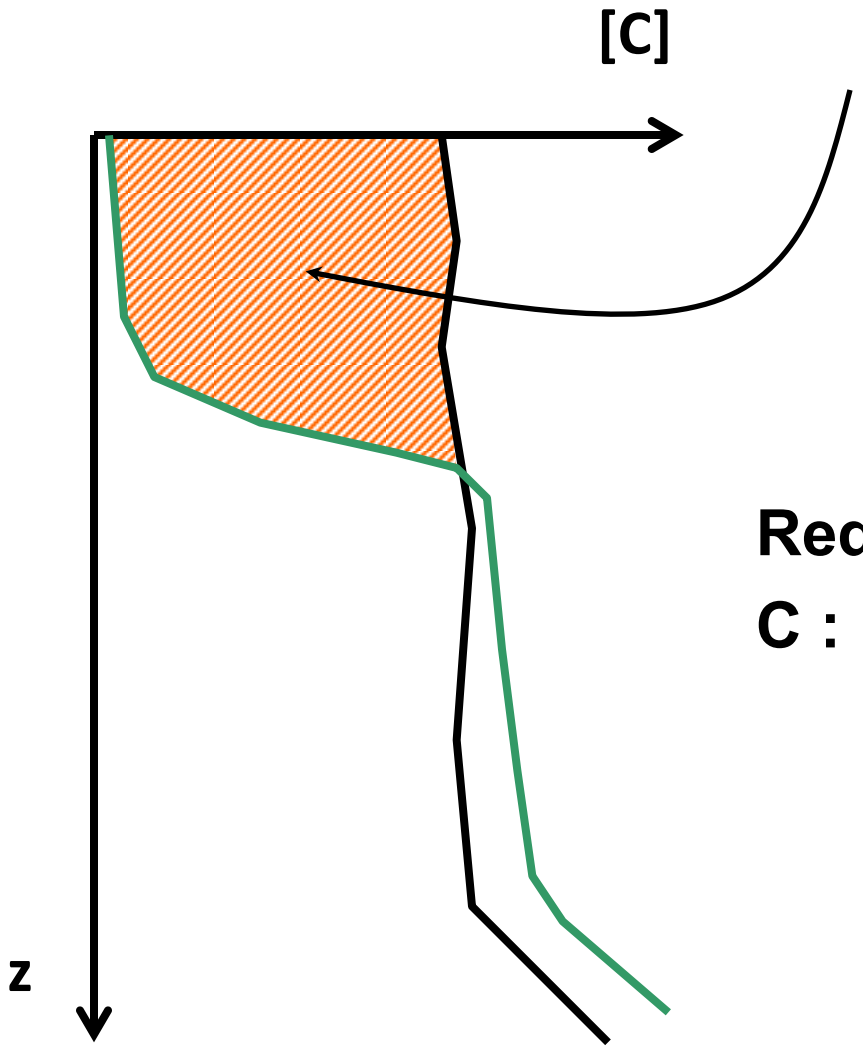


Month of recorded maximum chlorophyll values (SeaWIFS data from 1998-2002). (Iida and Saitoh 2007).

Methods



Methods

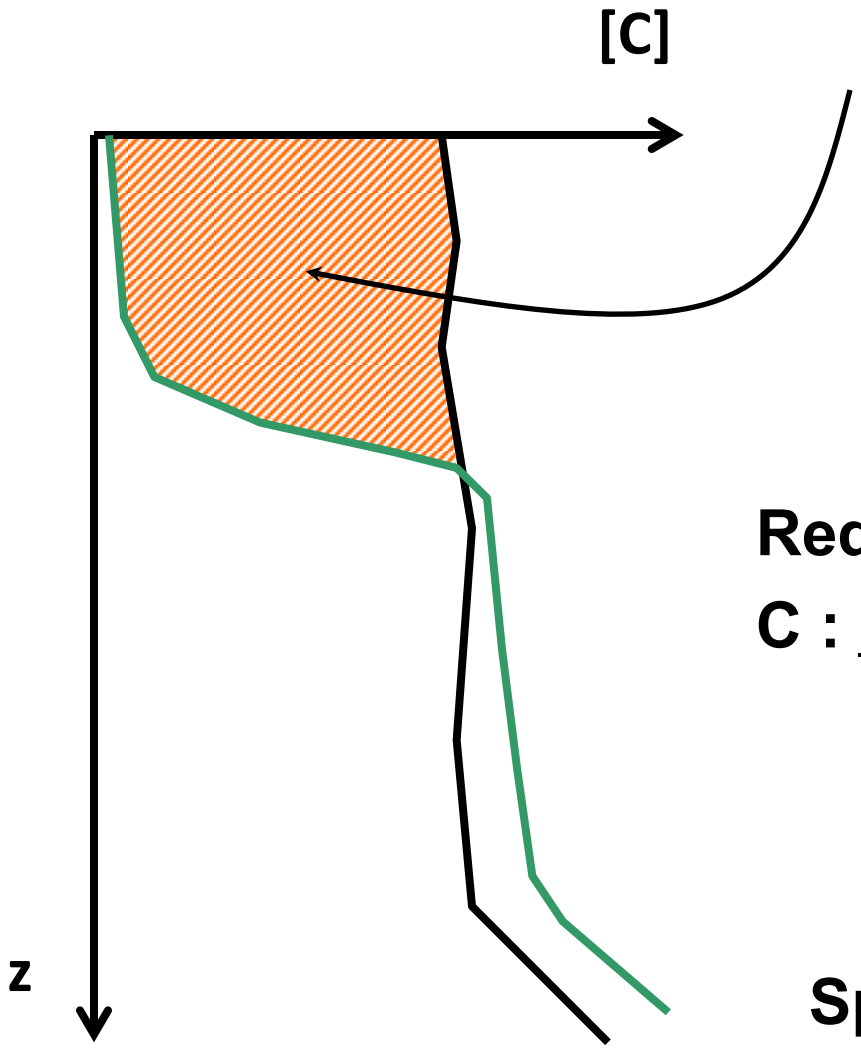


Nutrient consumption by phytoplankton ≈ net community production

Redfield ratio

C : N : P = 106 : 16 : 1

Methods



Nutrient consumption by phytoplankton ≈ net community production

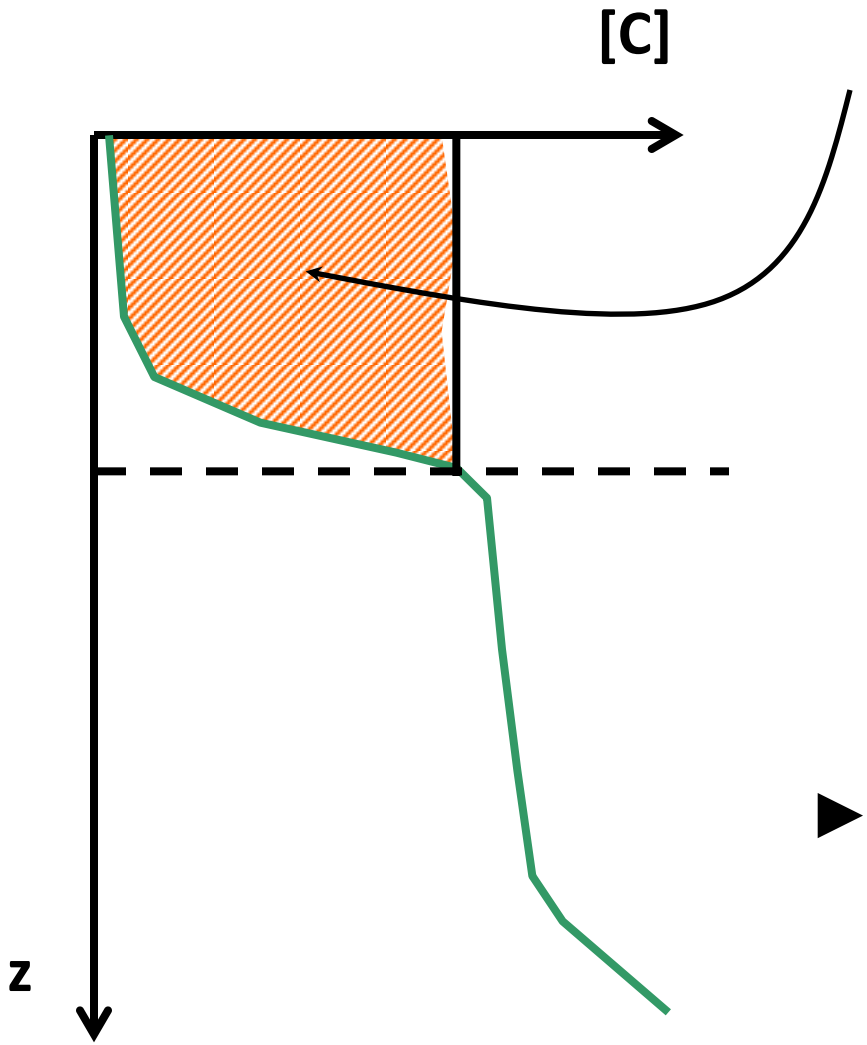
Redfield ratio

C : Si : N : P = 106 : 23 : 16 : 1

(Arzhanova et al. 1995)

Spring bloom timing from Brown et al. (2011)

Methods



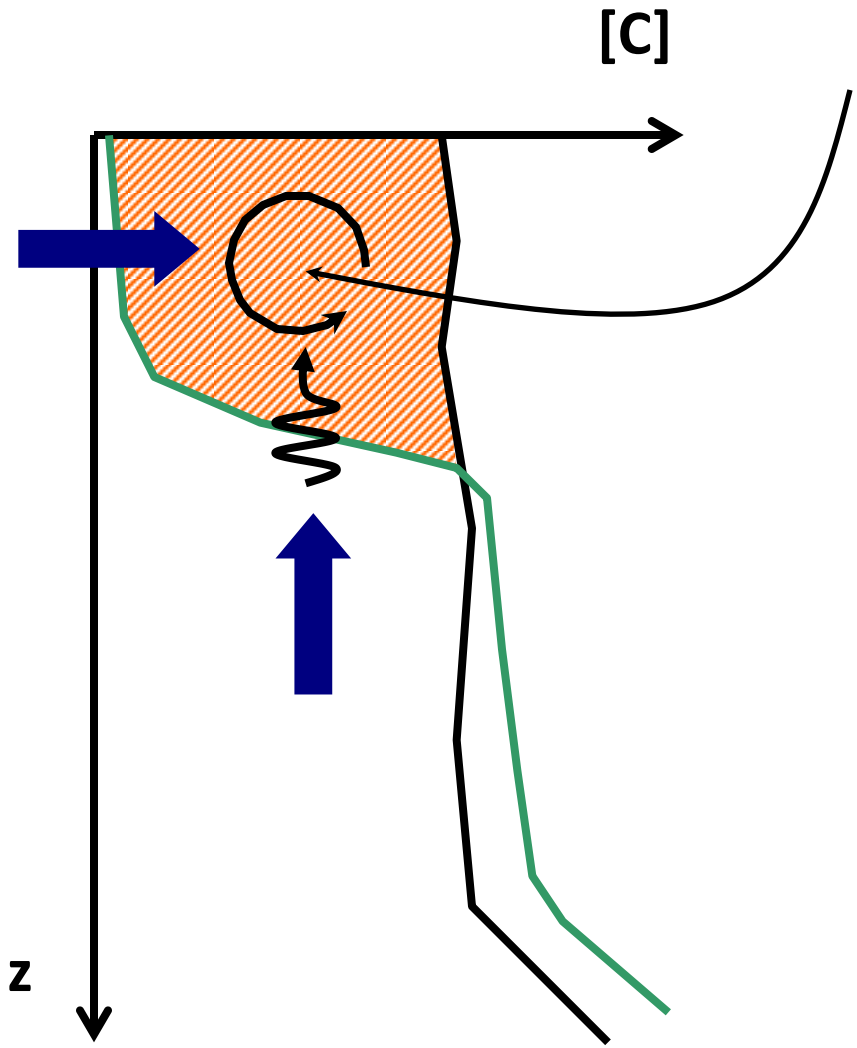
Nutrient consumption by phytoplankton ≈ net community production ?

Compensation depth (O_2 = 100 %)

Production ≈ destruction

► no nutrient consumption

Methods

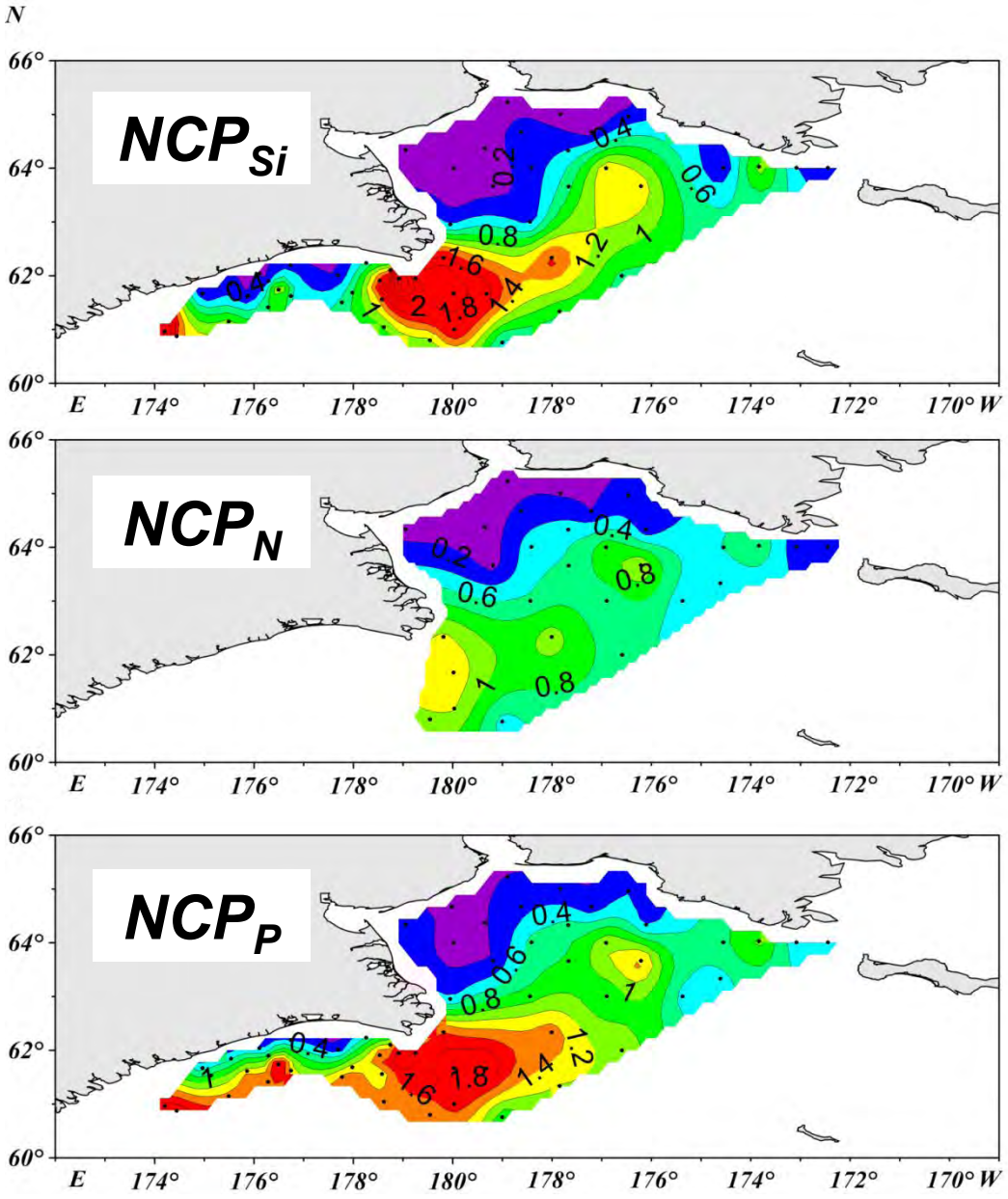


Nutrient consumption by phytoplankton ≈ net community production

Nutrient diffusion

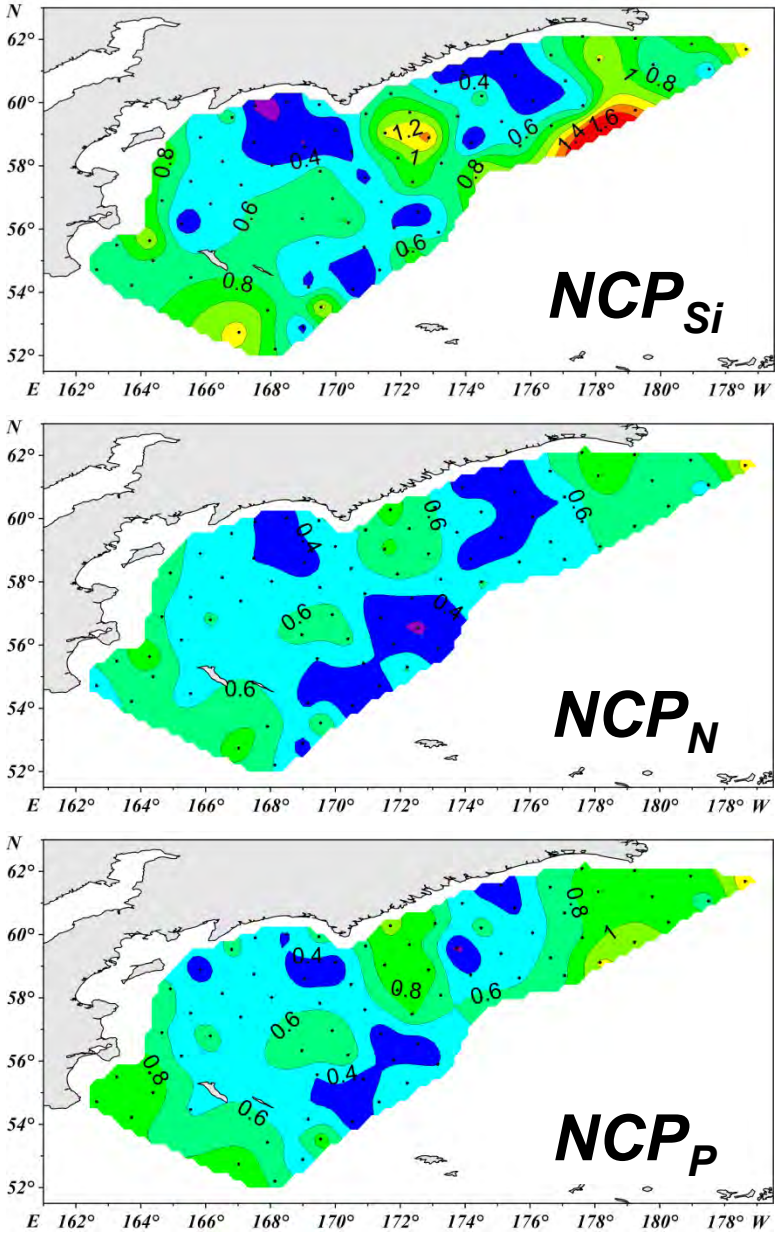
Advection

Remineralisation



Net community production (Si, N, P-based estimations)

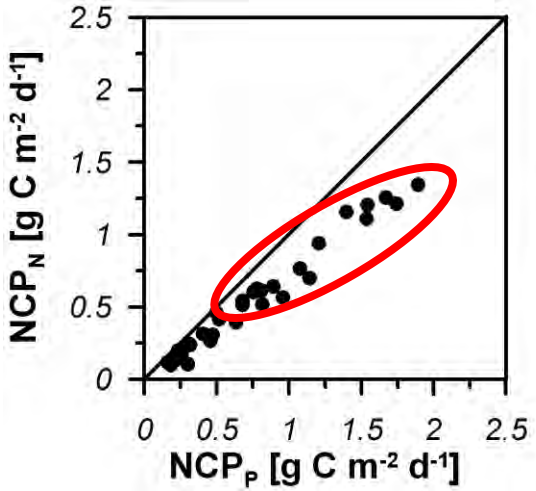
Area 1, July-August 2012 [mg C m^{-2} d^{-1}]

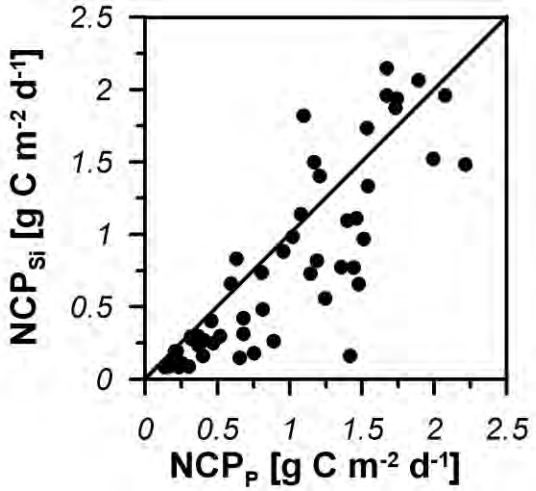


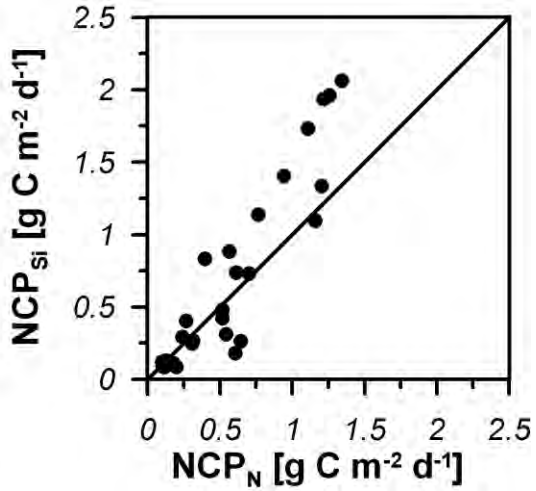
Net community production (Si, N, P-based estimations)

Area 2, September 2012 [mg C m^{-2} d^{-1}]

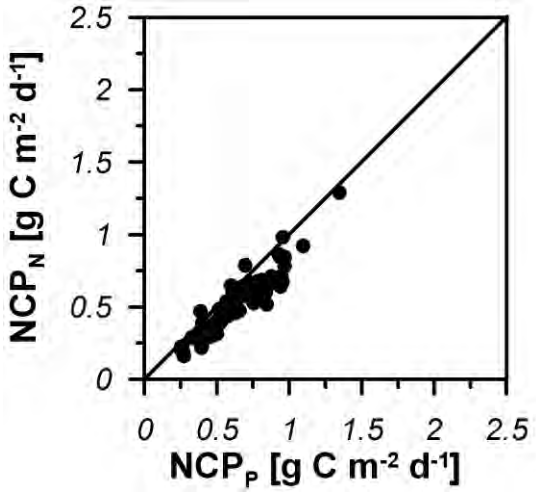
Area 1, July-August 2012

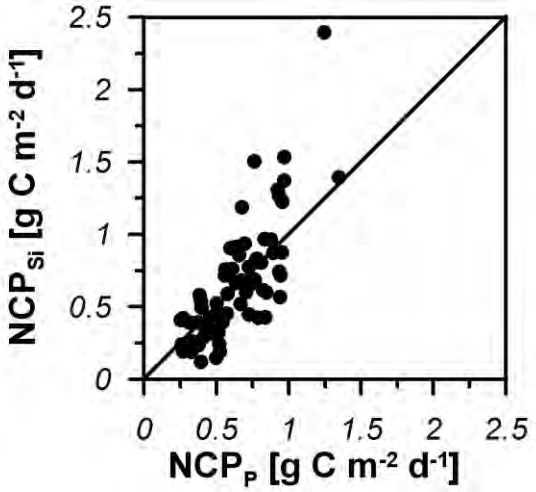


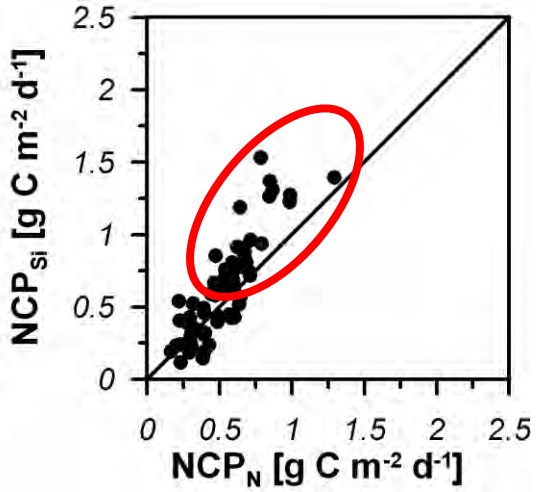




Area 2, September 2012







Comparisons of Si, N, P-based estimations of net community production [mg C m^{-2} d^{-1}]

Future directions

- Determination of vegetation period:
  - ► Sea ice retreat data
  - ► Net heat flux data
- Vertical nutrient flux estimations
- Advection estimations
- Calculations of NCP for 2004, 2008-2010

Conclusions

- Primary production features well represented in estimated NCP field
- Nitrogen remineralisation takes place within the euphotic layer
- Si- and P-based estimations of NCP are preferable

Thank you for attention!

Спасибо за внимание!

Basuk E.O., Kivva K.K., Chulchekov D.N. (2012)
Extremely cold thermal condition of waters in the Bering Sea in 2012
Voprosy promyslovoy okeanologii. Vol 9. № 1. (In Russian).

Thank you for attention!

Спасибо за внимание!