

Biogeochemistry in the hotspots of the Chukchi Sea

Shigeto Nishino¹, Takashi Kikuchi¹, Toru Hirawake²,
Michiyo Yamamoto-Kawai³ and Michio Aoyama⁴

¹JAMSTEC-RIGC

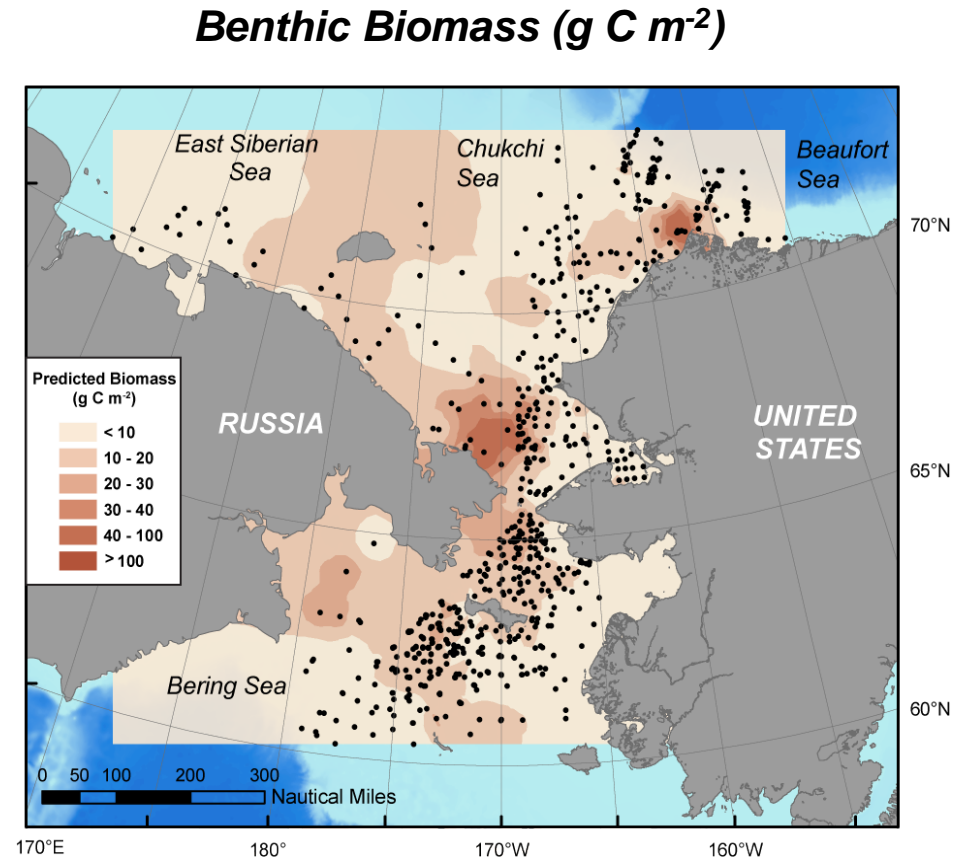
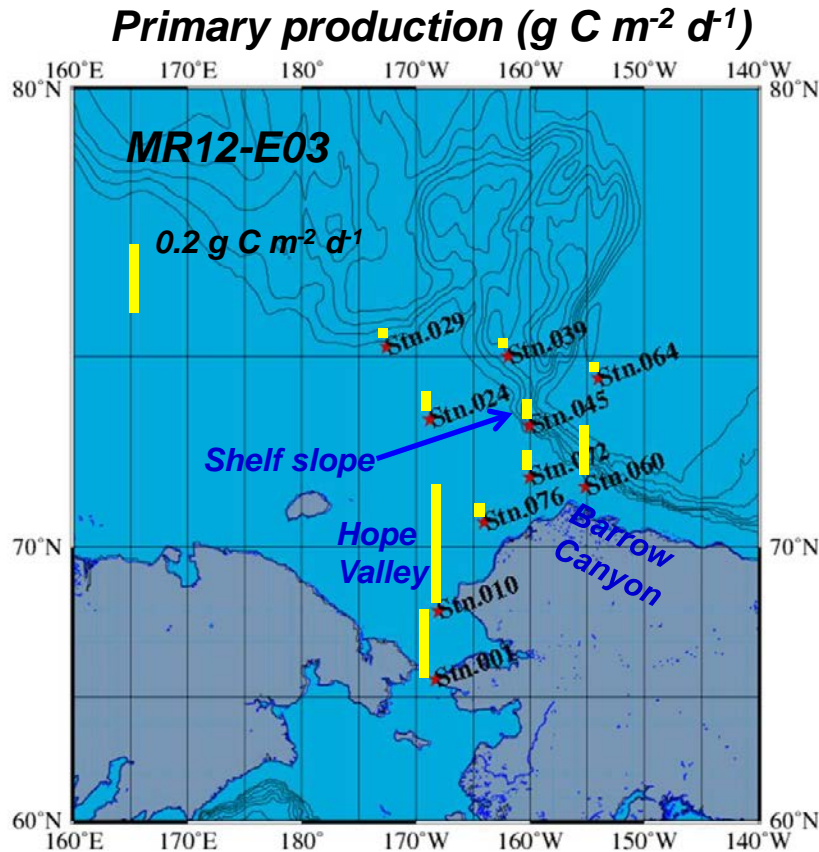
²Faculty of Fisheries Sciences, Hokkaido University

³Tokyo University of Marine Science and Technology

⁴Meteorological Research Institute,
Japan Meteorological Agency



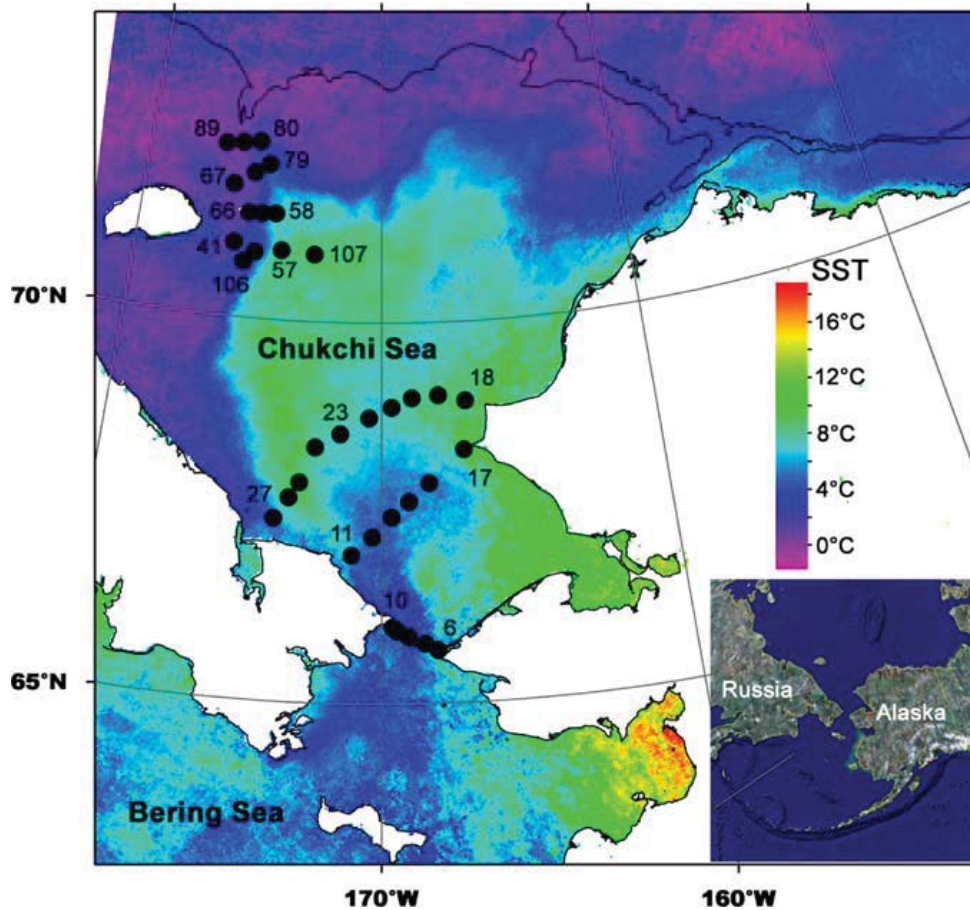
Three different type biological hotspots: Hope Valley, Barrow Canyon, and Shelf Slope



Grebmeier *et al.* [2006]

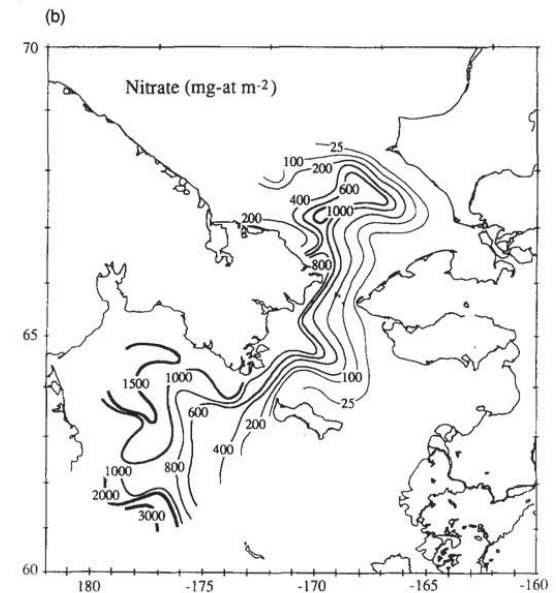
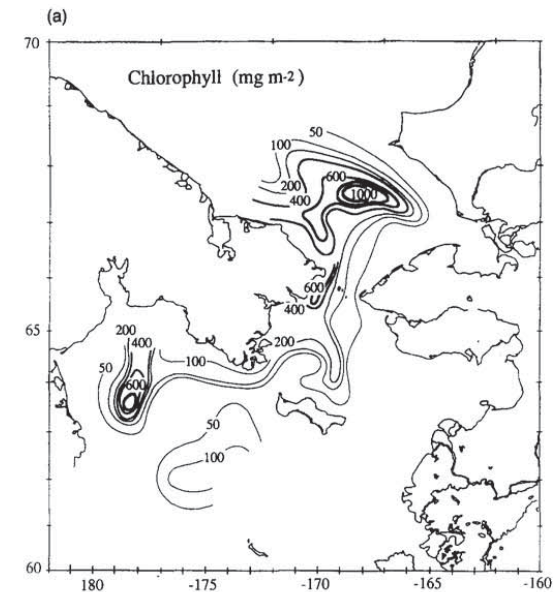
Hope Valley Hotspot

Dome-like structure of high nutrients

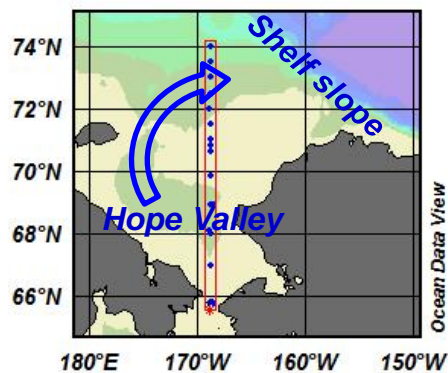


RUSALCA 2004 stations and 7-day composite AVHRR sea-surface temperature during August 11–17, 2004.

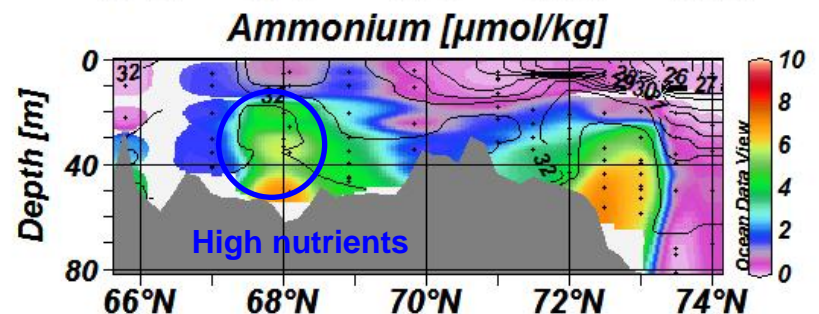
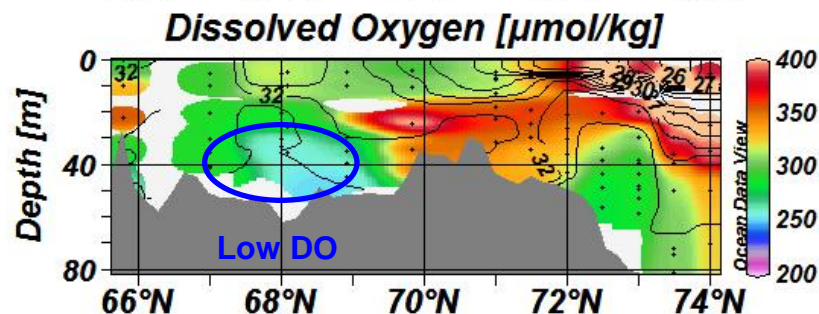
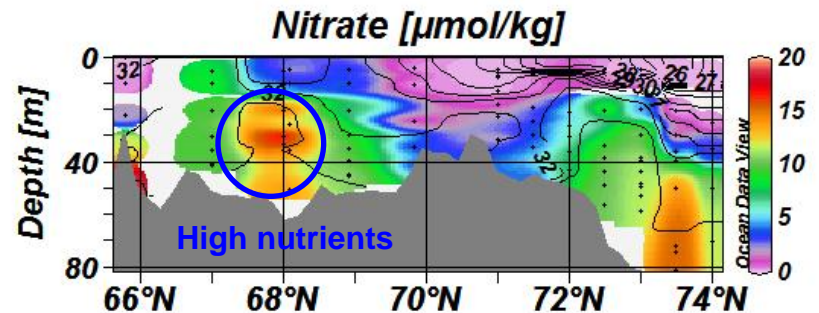
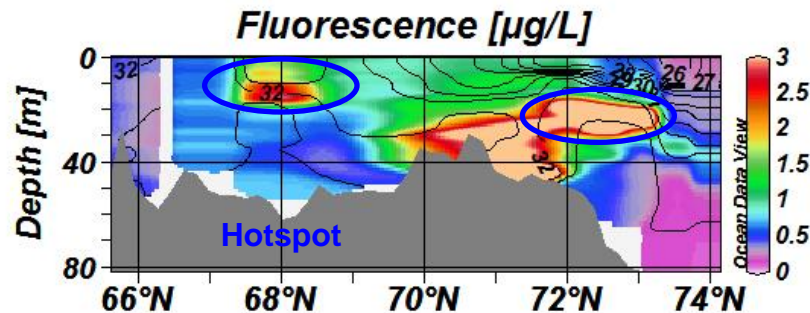
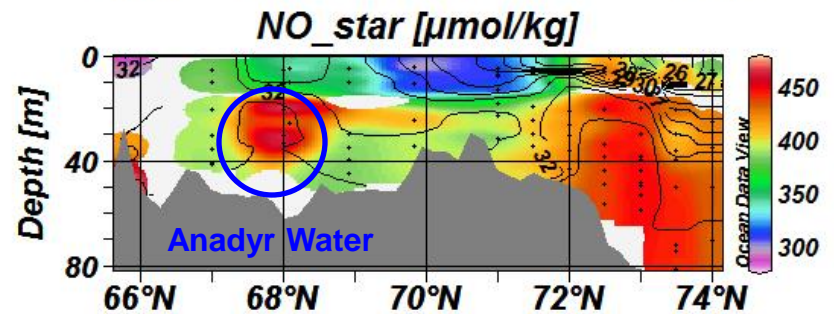
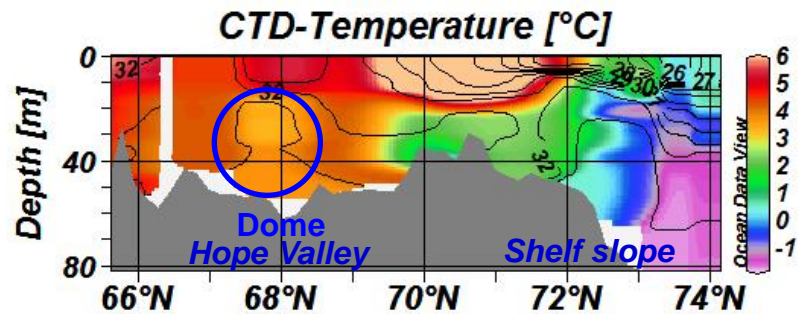
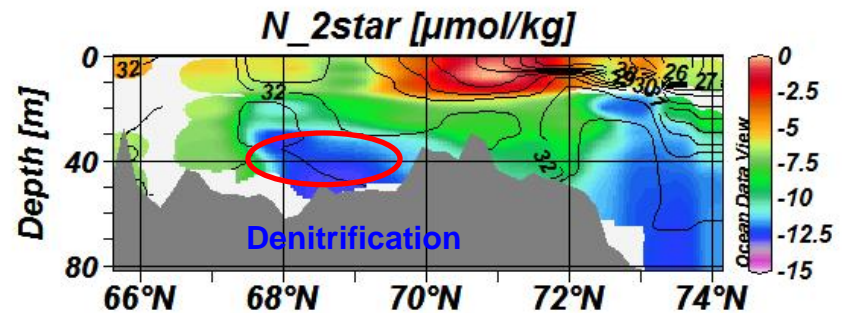
Hopcroft *et al.* [2010]



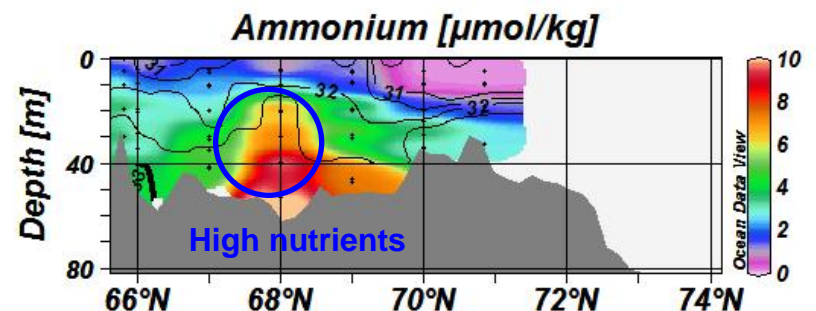
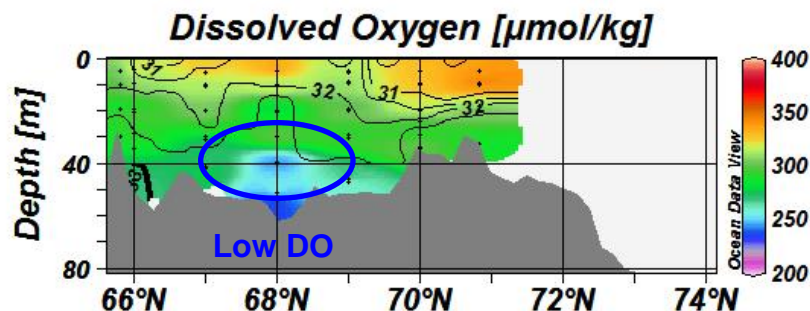
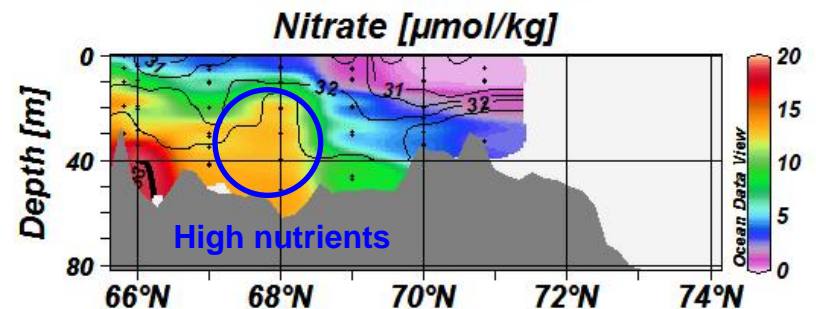
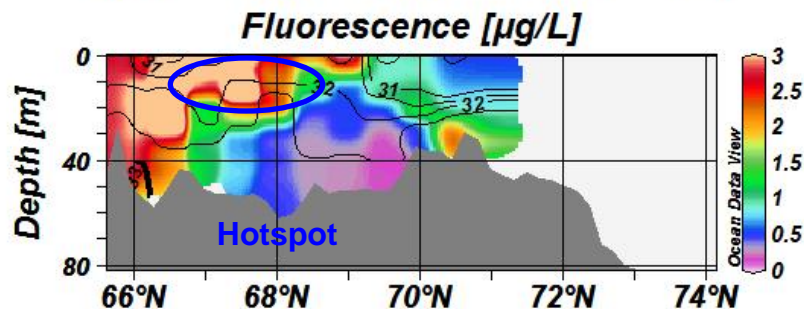
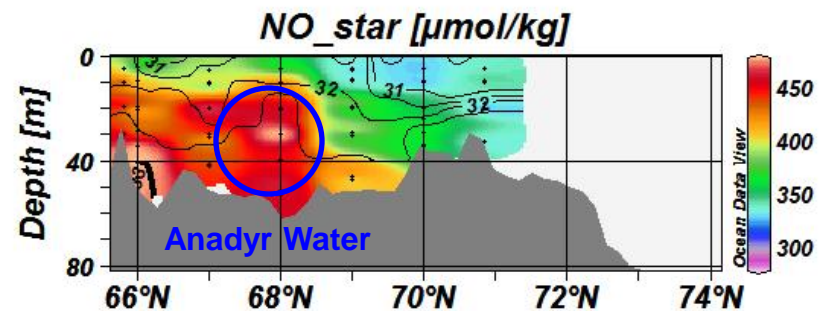
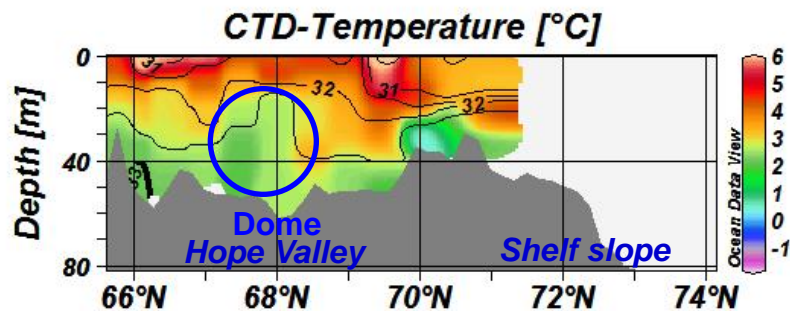
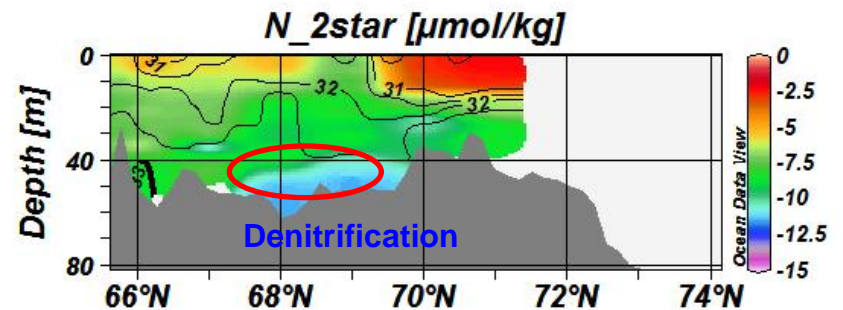
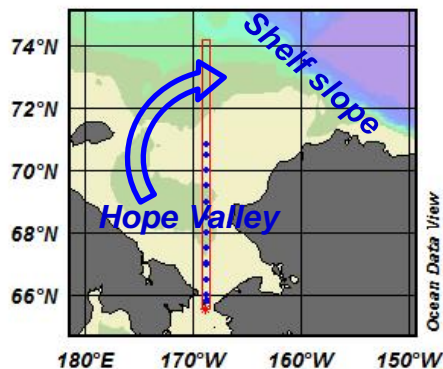
Chlorophyll and Nitrate during July 26 – September 2, 1988.
Springer and McRoy [1993]

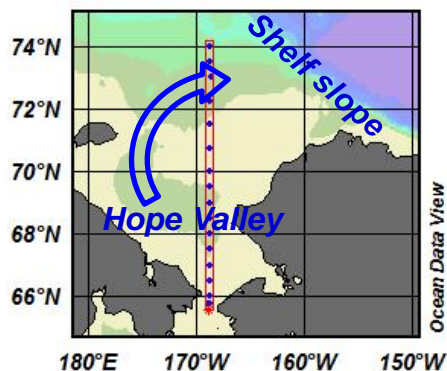


R/V Mirai 2004

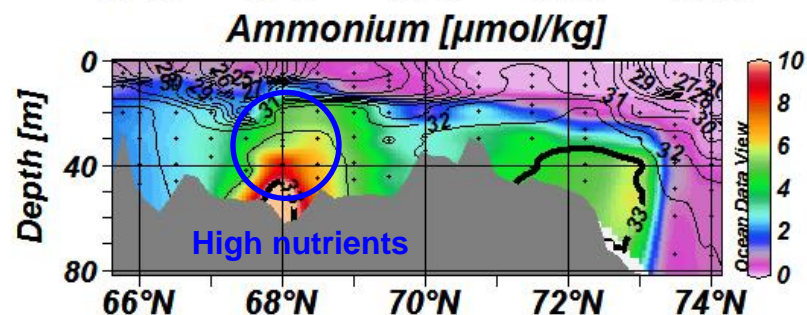
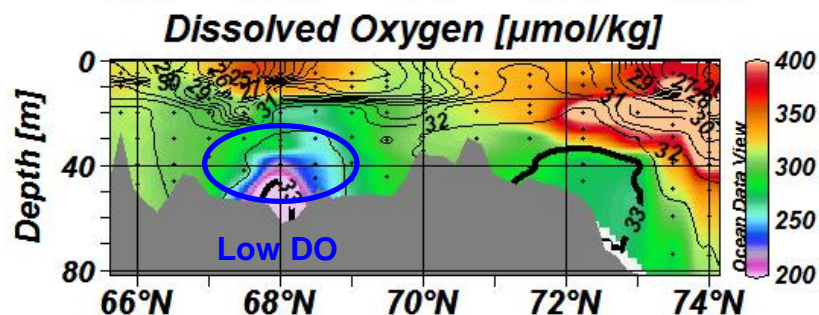
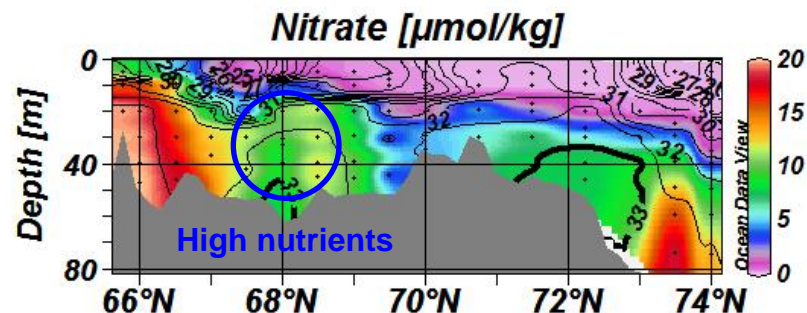
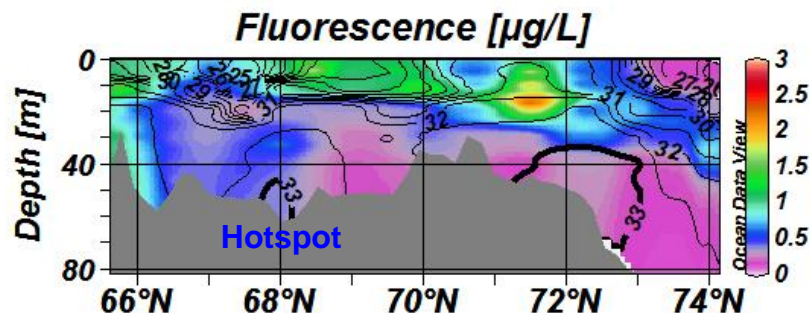
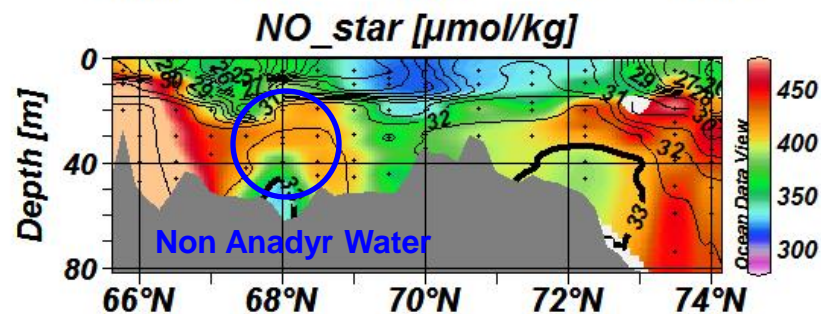
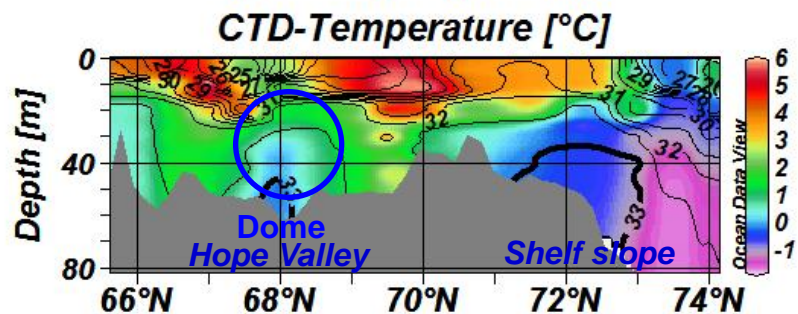
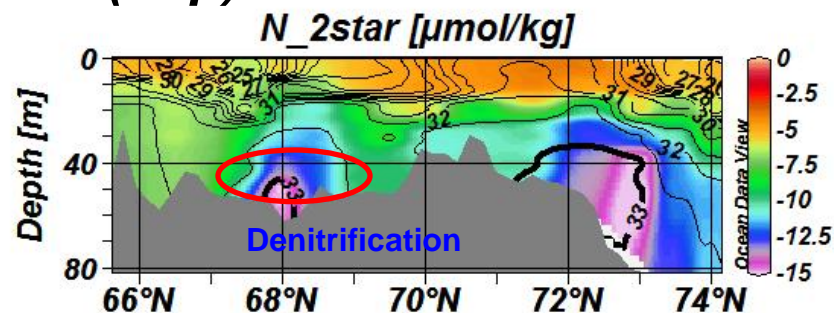


R/V Mirai 2008

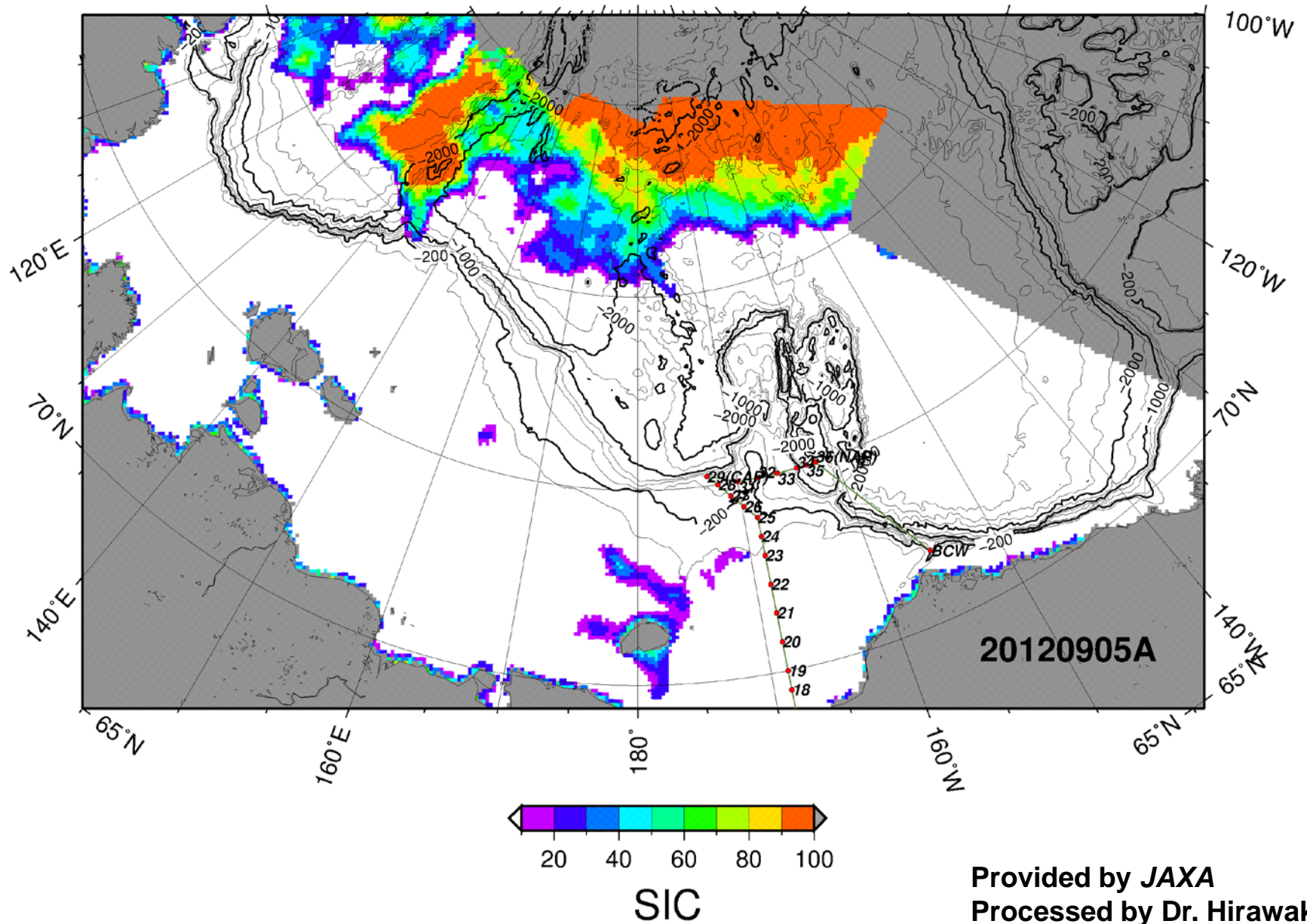


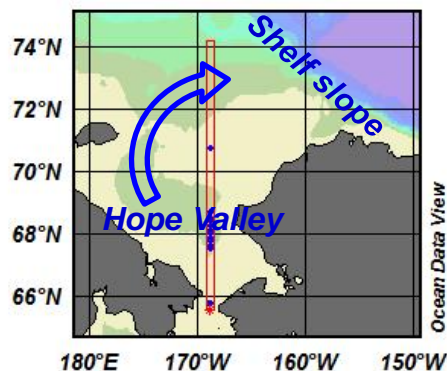


R/V Mirai 2012 (Sep)

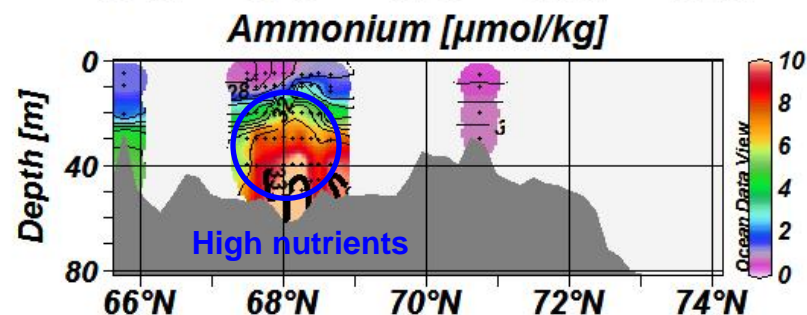
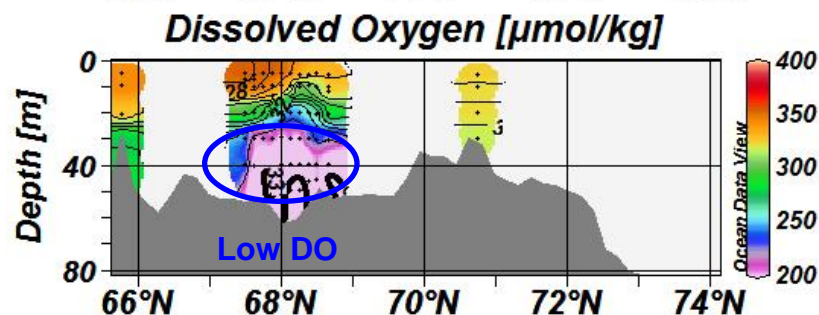
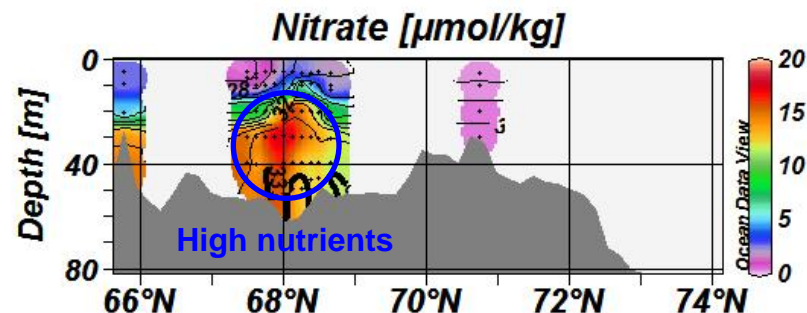
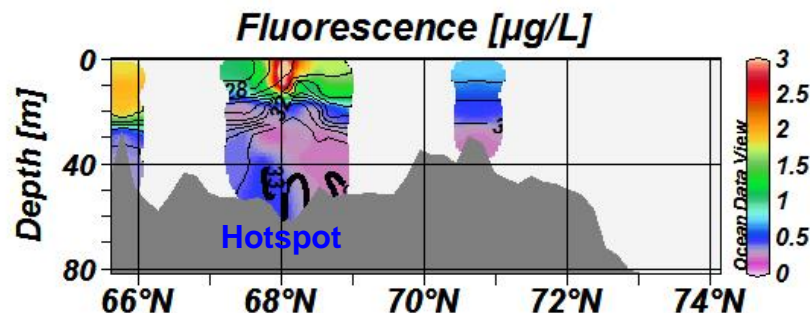
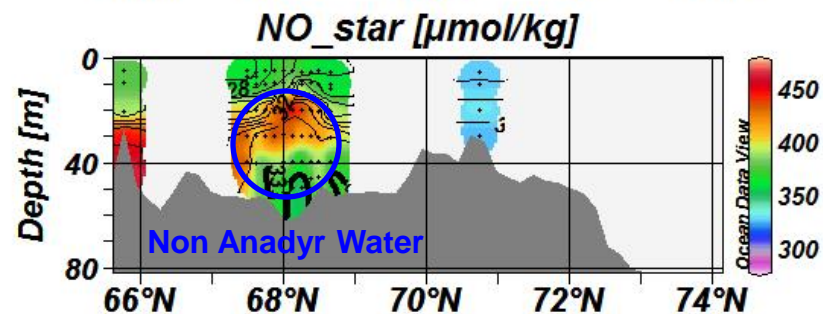
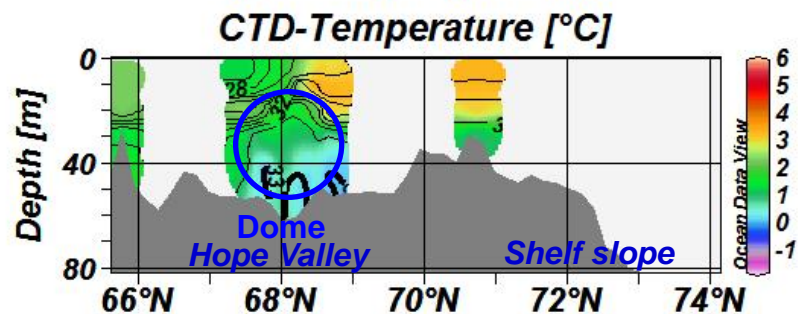
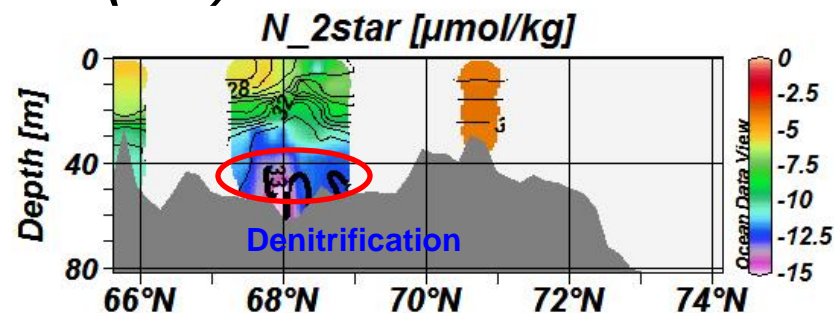


WindSat data: sea ice concentration (SIC)

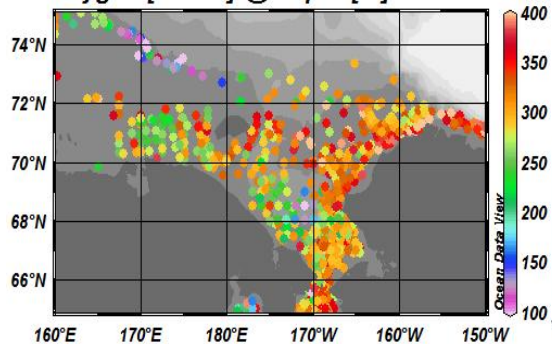




R/V Mirai 2012 (Oct)

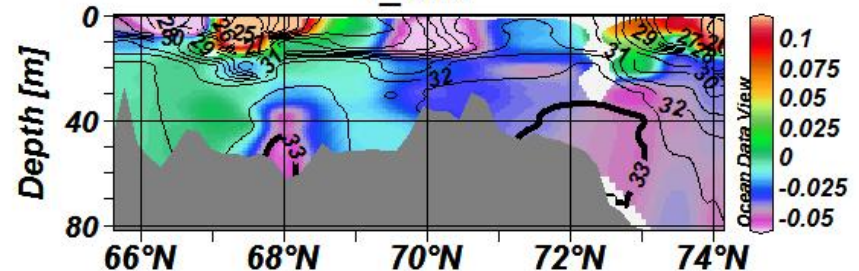


Oxygen [$\mu\text{mol/l}$] @ Depth [m]=Bottom

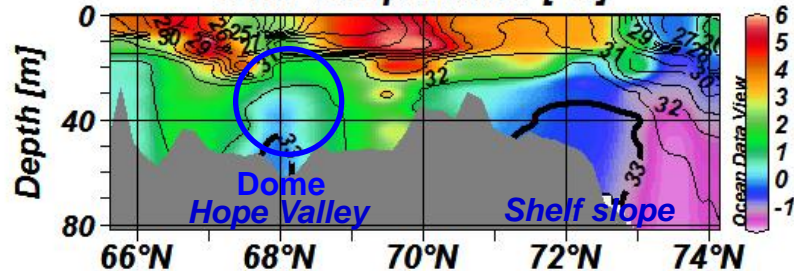


R/V Mirai 2012 (Sep)

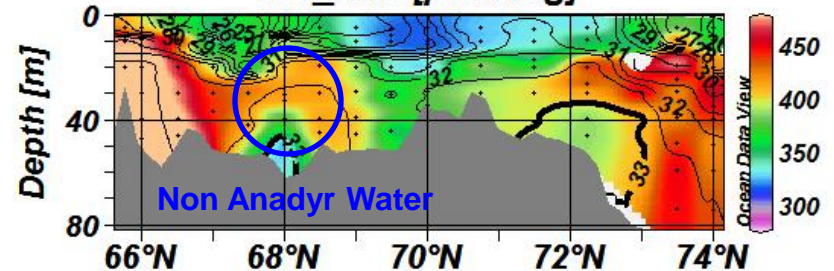
f_{SIM}



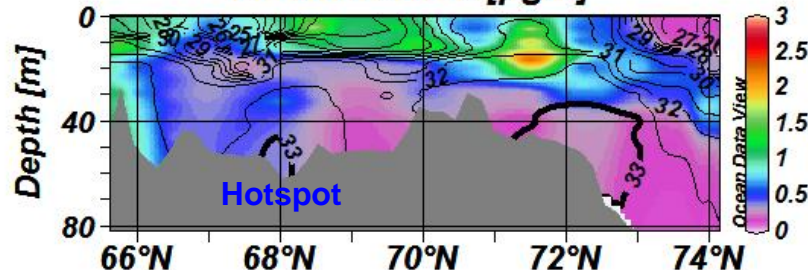
CTD-Temperature [$^{\circ}\text{C}$]



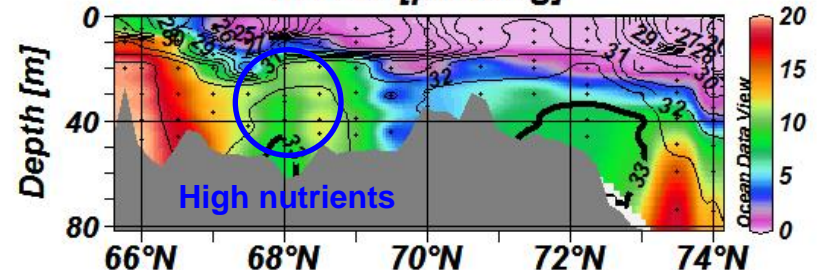
NO_{star} [$\mu\text{mol/kg}$]



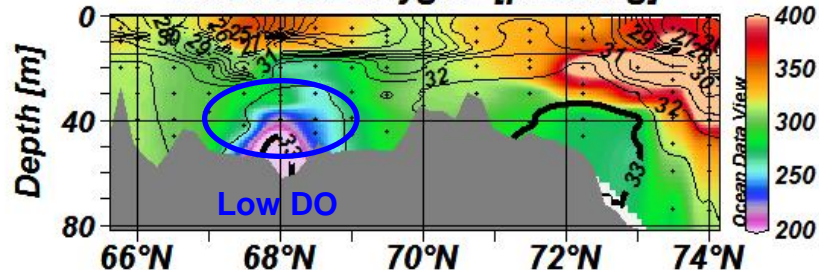
Fluorescence [$\mu\text{g/L}$]



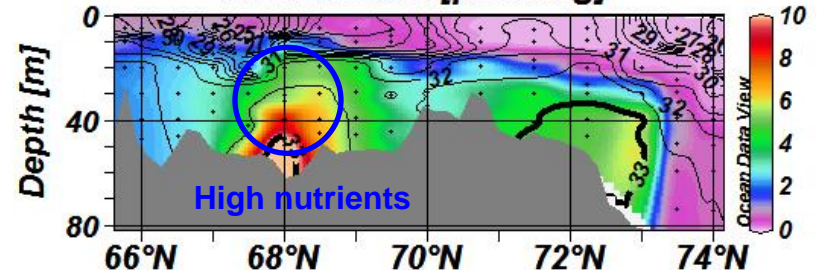
Nitrate [$\mu\text{mol/kg}$]



Dissolved Oxygen [$\mu\text{mol/kg}$]



Ammonium [$\mu\text{mol/kg}$]



NCEP/NCAR Reanalysis SLP

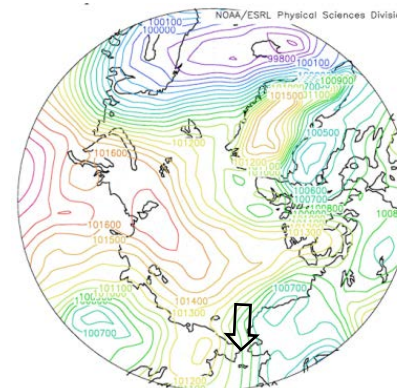
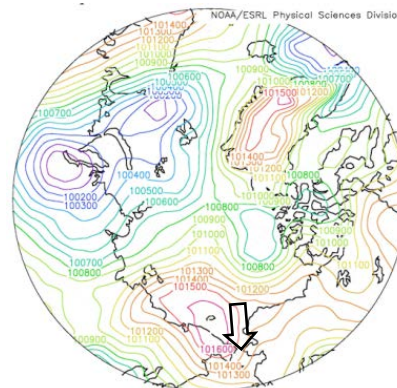
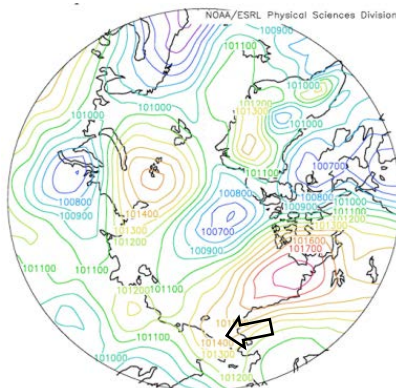
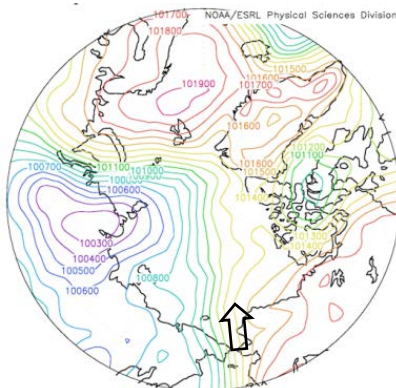
Aug 01-15

Aug 16-31

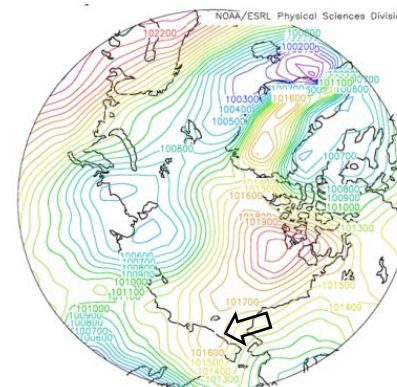
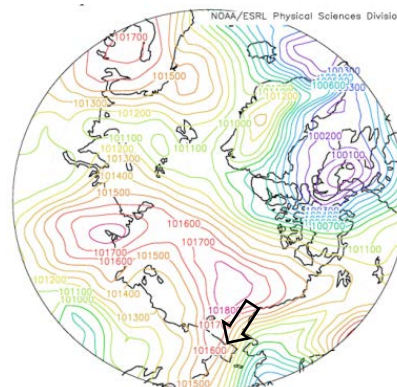
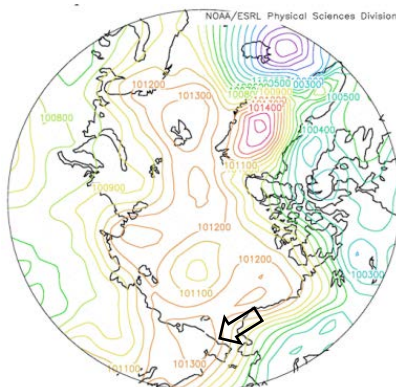
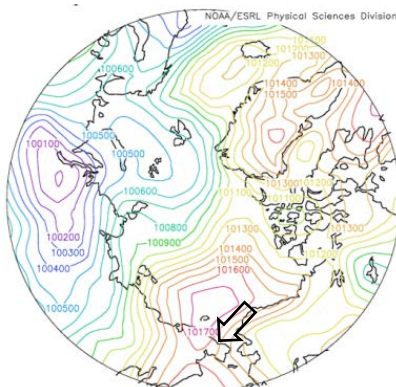
Sep 01-15

Sep 16-30

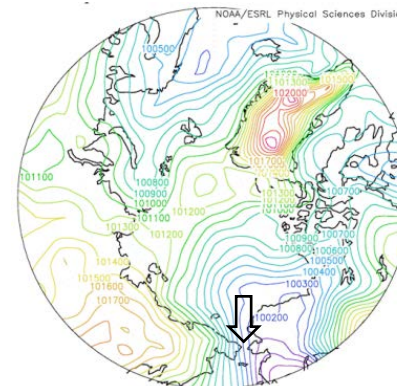
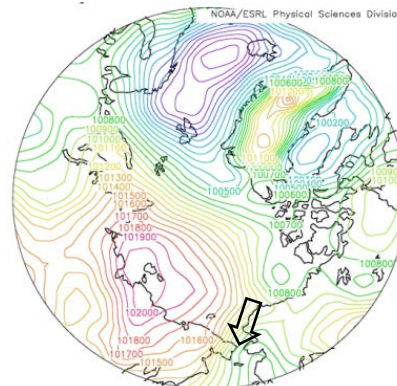
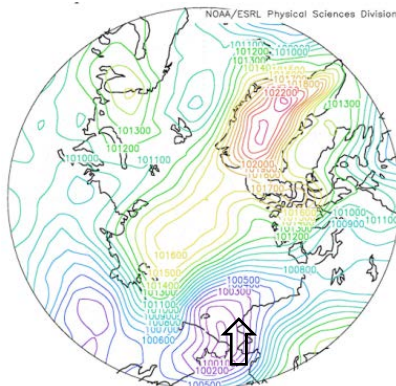
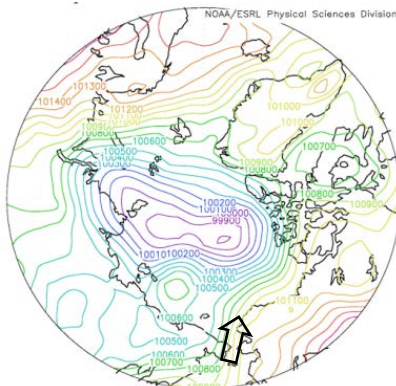
2004



2008



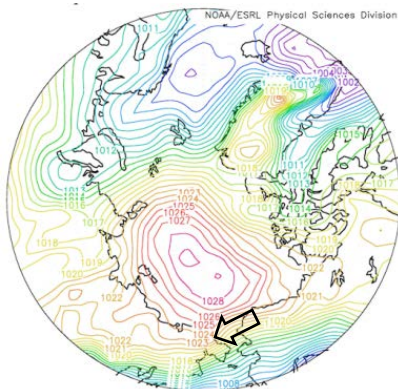
2012



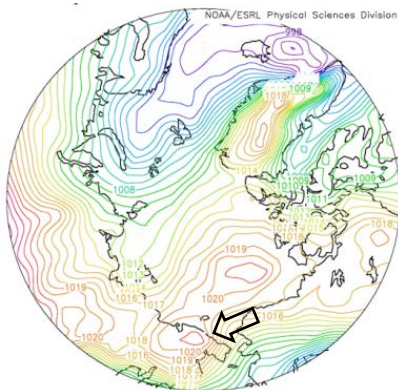
NCEP/NCAR Reanalysis SLP

Jan-Mar

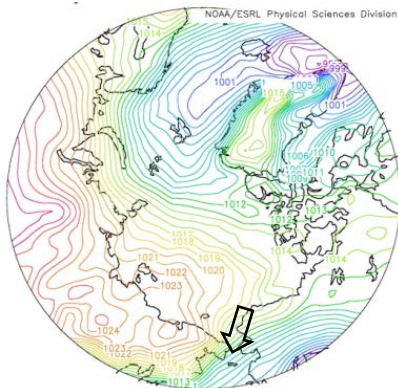
2004



2008

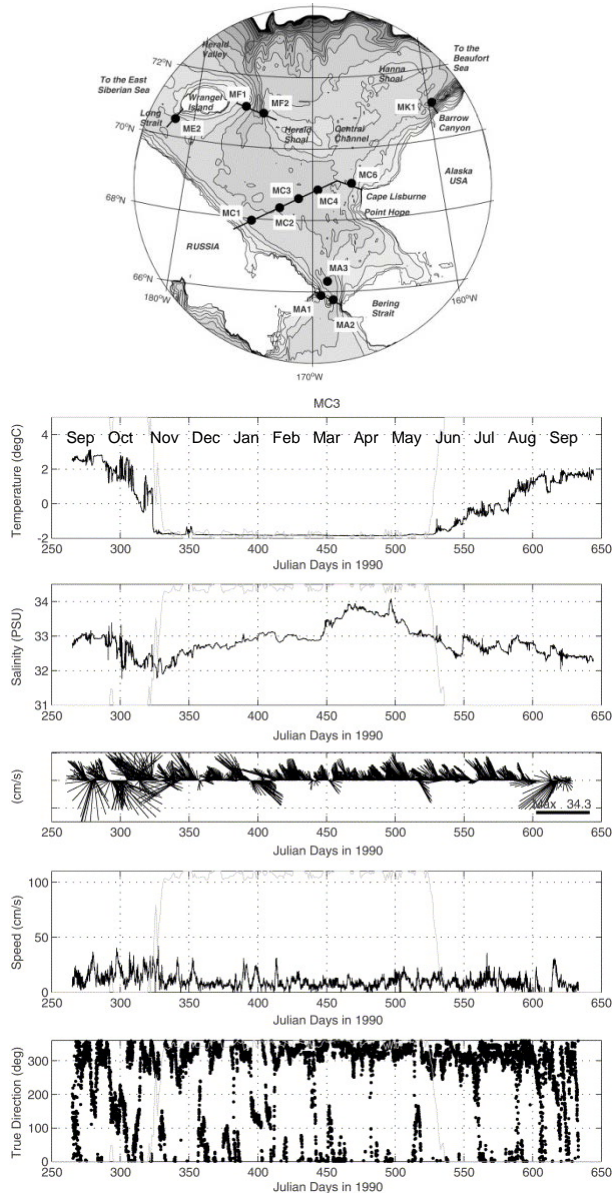


2012



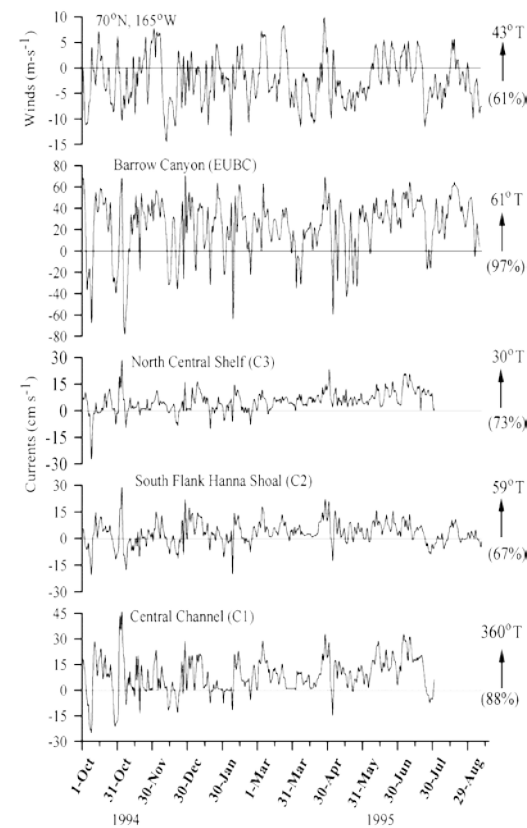
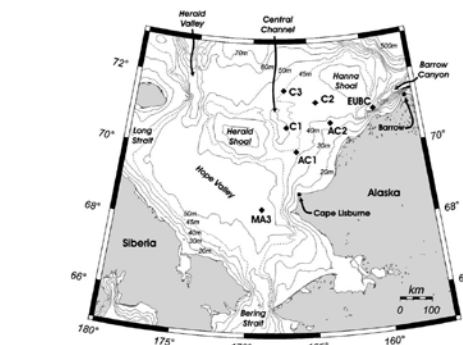
Winter water season

Jan-Mar



Woodgate et al. [2005]

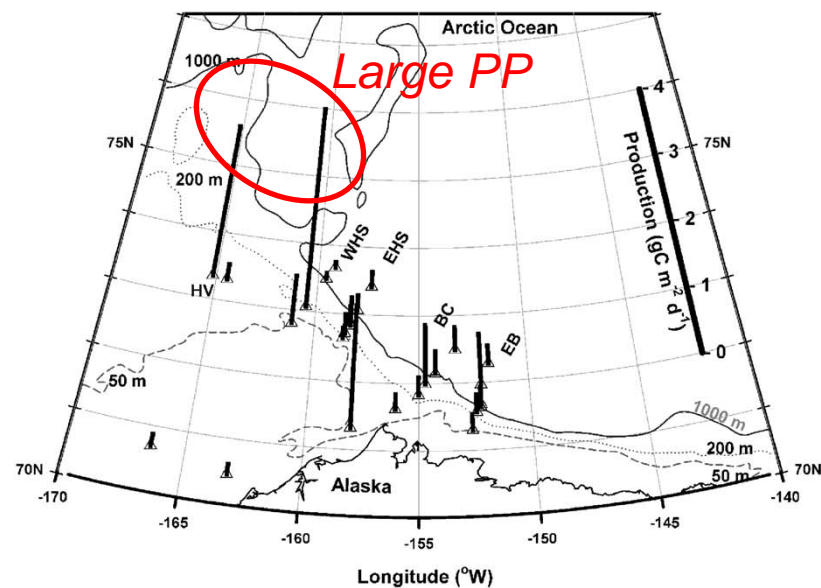
Winds vs. currents in winter



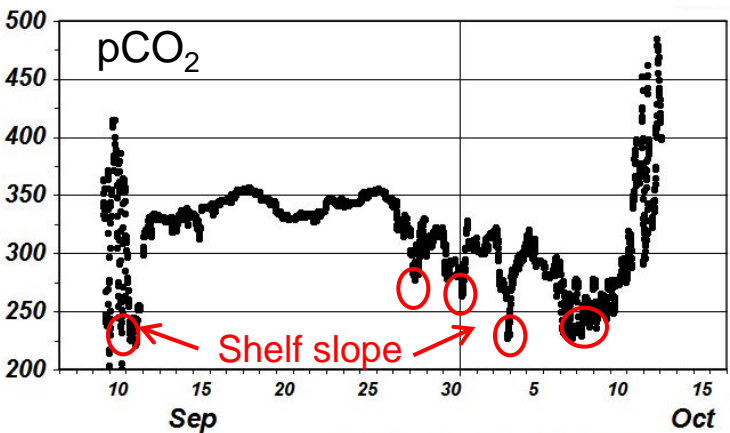
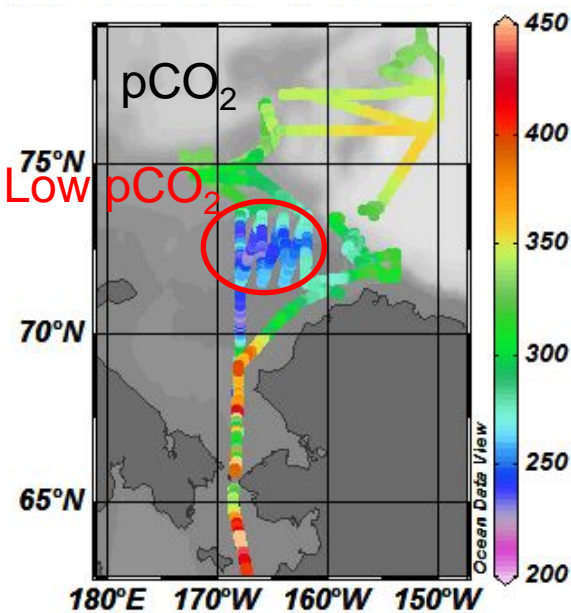
Weingartner et al. [2005]

Chukchi Shelf Slope Hotspot

Effective biological pump



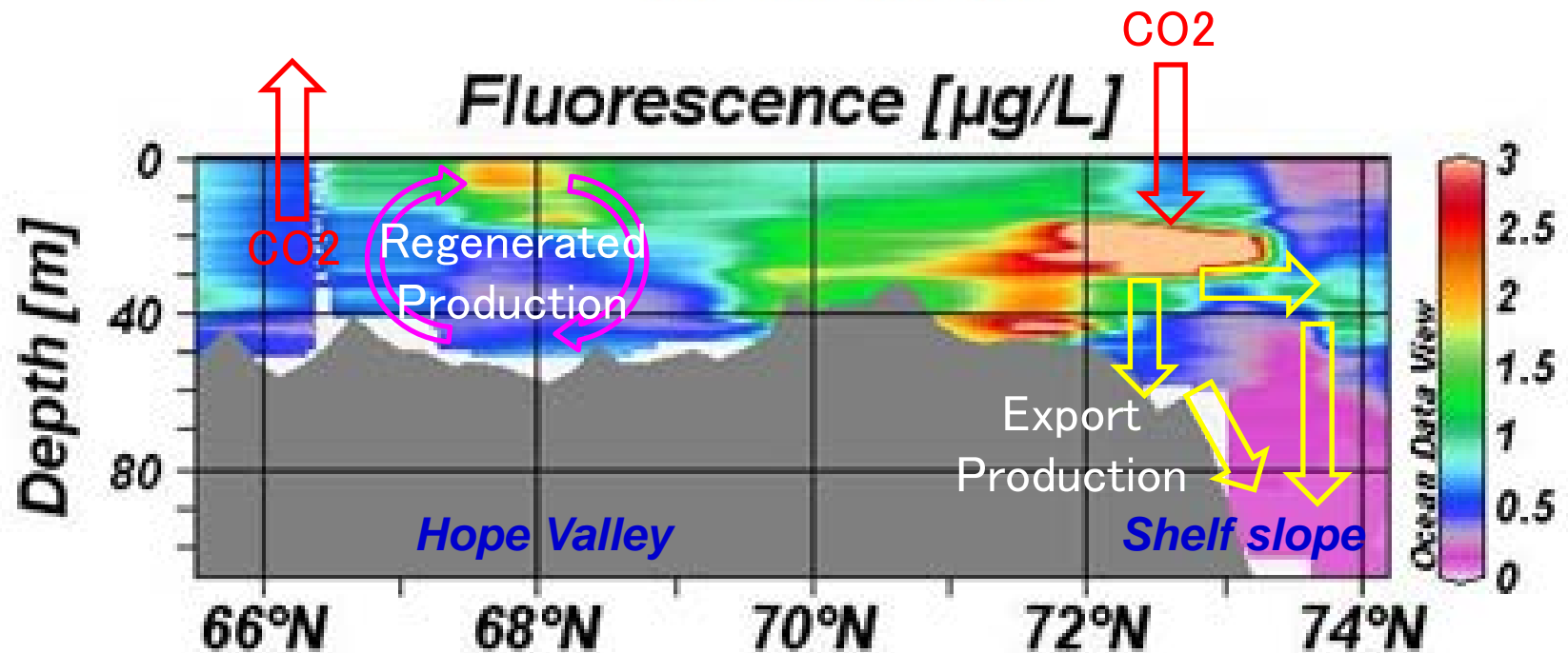
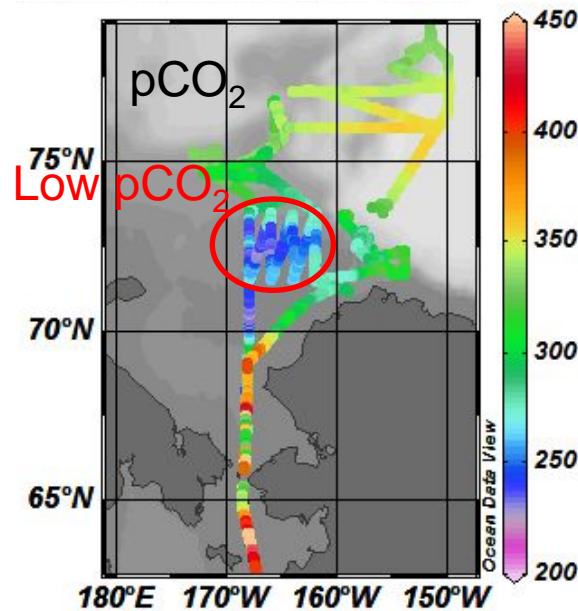
Euphotic zone integrated net daily production during summer 2002 (07/18/02–08/21/02).
Hill and Cota [2005]



pCO_2 in sea surface water and its time series during summer 2009 (09/07/09–10/15/09) obtained from R/V Mirai.

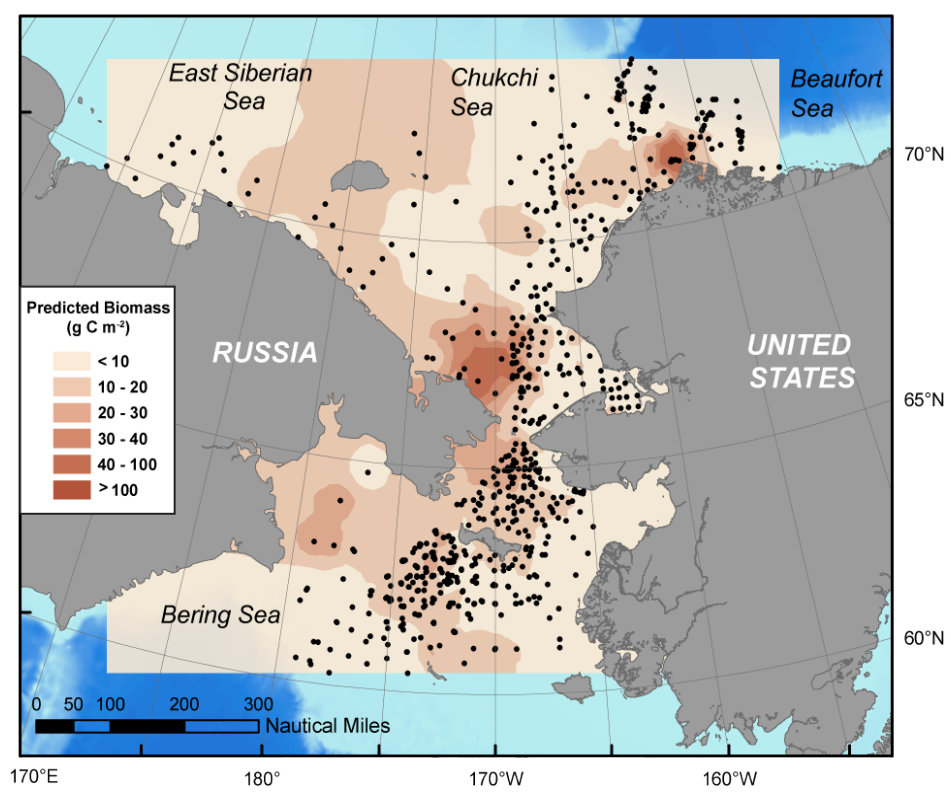
Chukchi Shelf Slope:

*a site for effective
biological pump*

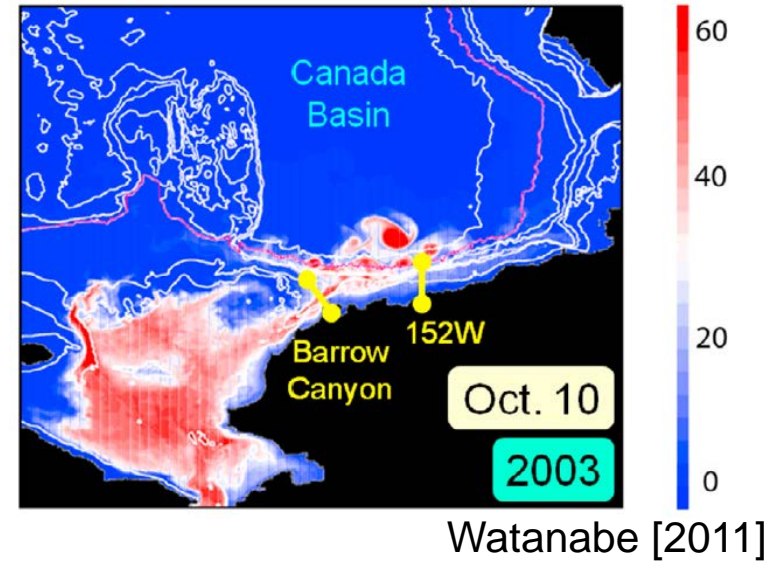
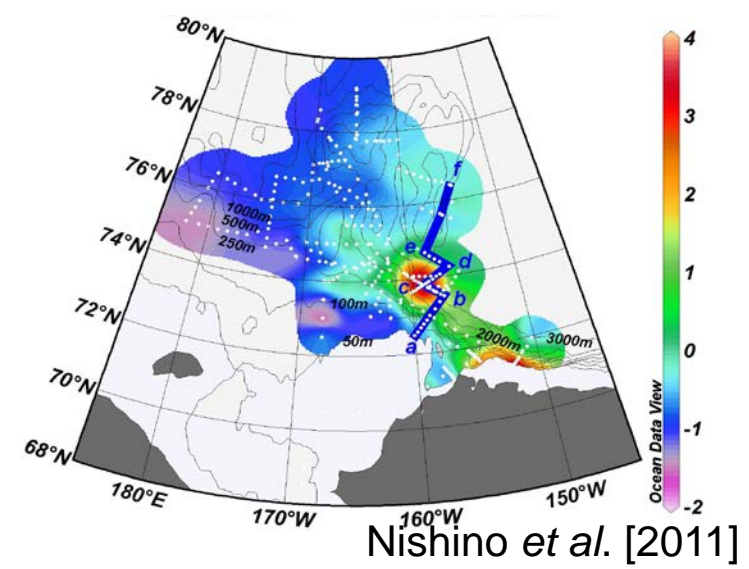


Barrow Canyon Hotspot

Nutrient supplies by upwelling and eddies



Benthic biomass distribution in the Chukchi Sea.
Grebmeier et al. [2006]

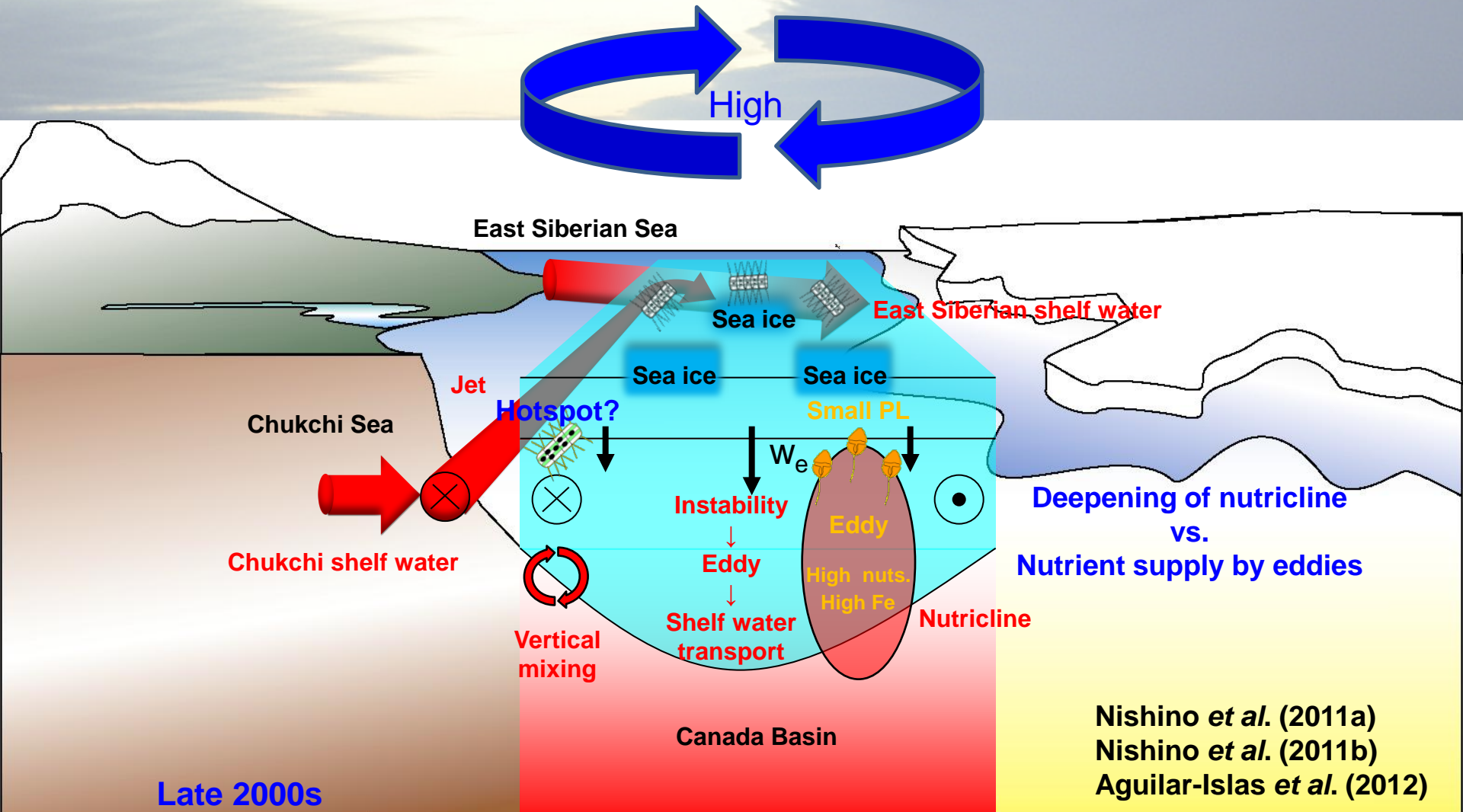


Warm-core eddy observed from the R/V Mirai in 2010 and numerical simulation of the eddy.

Recent changes in the western Arctic Ocean

Enhancement of ocean circulation due to sea ice decrease

- deepening of nutricline and inhibiting the shelf water spreading*
- producing eddies containing shelf water with high nutrients*



Summary and Discussion

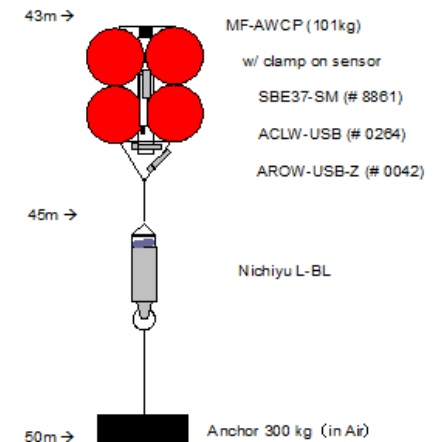
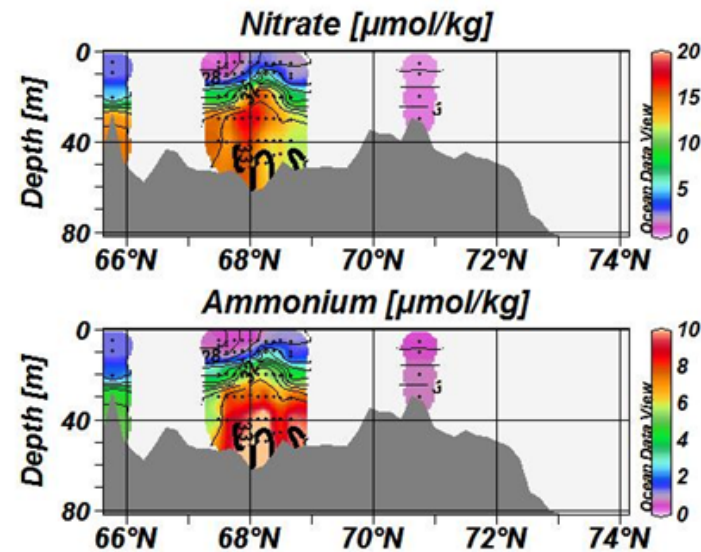
In 2012, the Hope Valley Hotspot was maintained not by the inflow of nutrient-rich Anadyr Water (new production) but by the nutrient (**ammonium**) supply from the bottom water (**regenerated production**).

In 2012, the bottom water in the Hope Valley had extremely **low oxygen and high ammonium** concentrations. The water was largely influenced by the brine rejection, and therefore, the water seems to be largely influenced by the **Pacific-origin winter water**. The winter water would have remained on the Chukchi Sea shelf because of the northerly wind in winter.

In 2012, at the Hope Valley Hotspot the surface **Chl-*a* concentration was low** compared with that in the usual years, in spite of high concentrations of nutrients in the bottom water. This is because the **surface stratification was strong** due to the surface freshwater that was resulted from the recent melting of sea ice, which has remained until this summer around the Wrangel Island.

Summary and Discussion

If the surface stratification was weakened in autumn 2012 by the cooling and convection, nutrients in the bottom water could be supplied to the surface and may resulted in **phytoplankton bloom in the autumn season**. We expect that such seasonal variation could be captured by the mooring at the Hope Valley deployed by the R/V Mirai in 2012.



We thank the captain, officers, and crew of the R/V Mirai, which was operated by Global Ocean Development, Inc. We also thank the staff of Marine Works Japan, Ltd. for their skillful work aboard the ship and for data processing.



MR12-E03 Arctic Cruise