The role of zooplankton in buffering geographical heterogeneity of primary productivity

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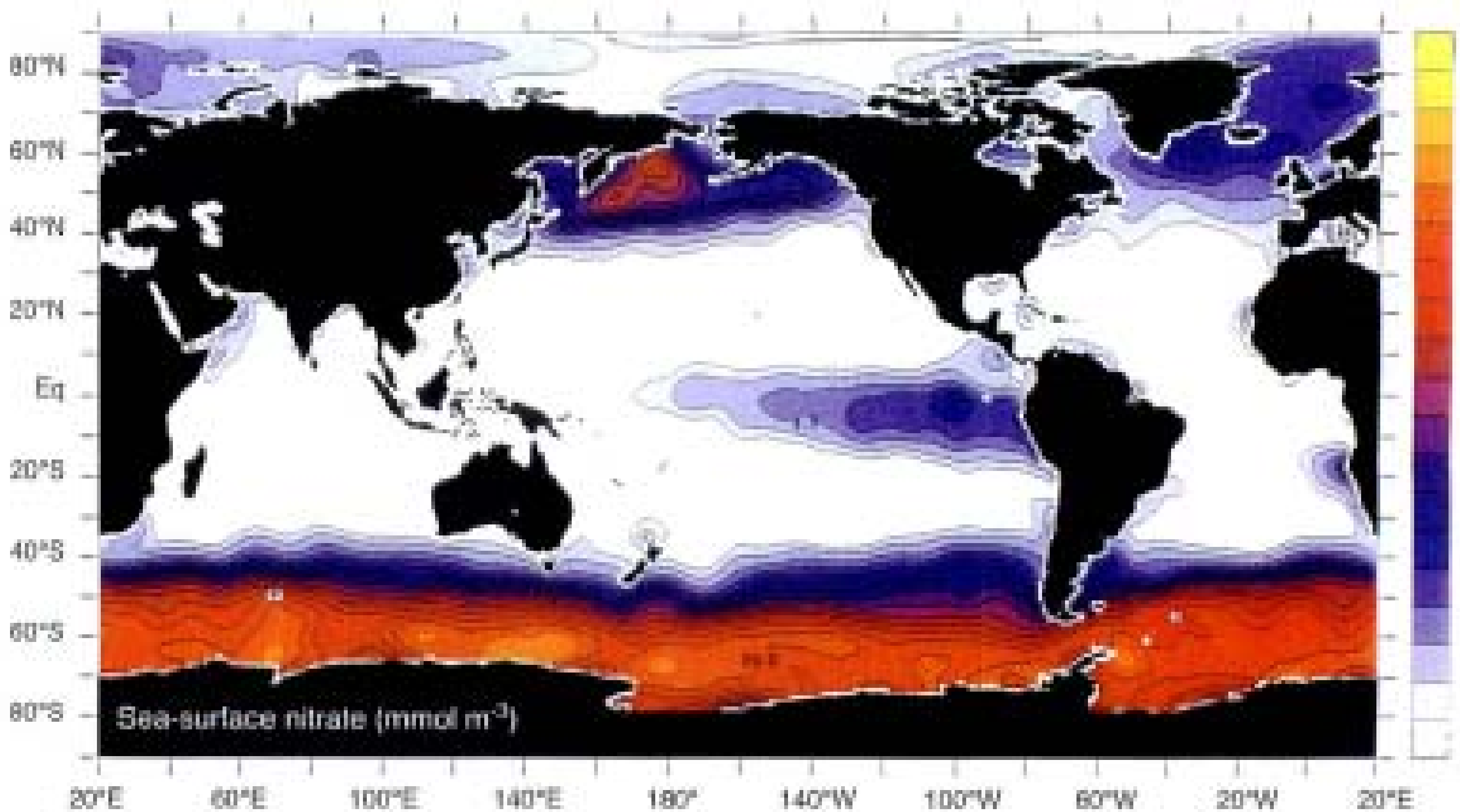
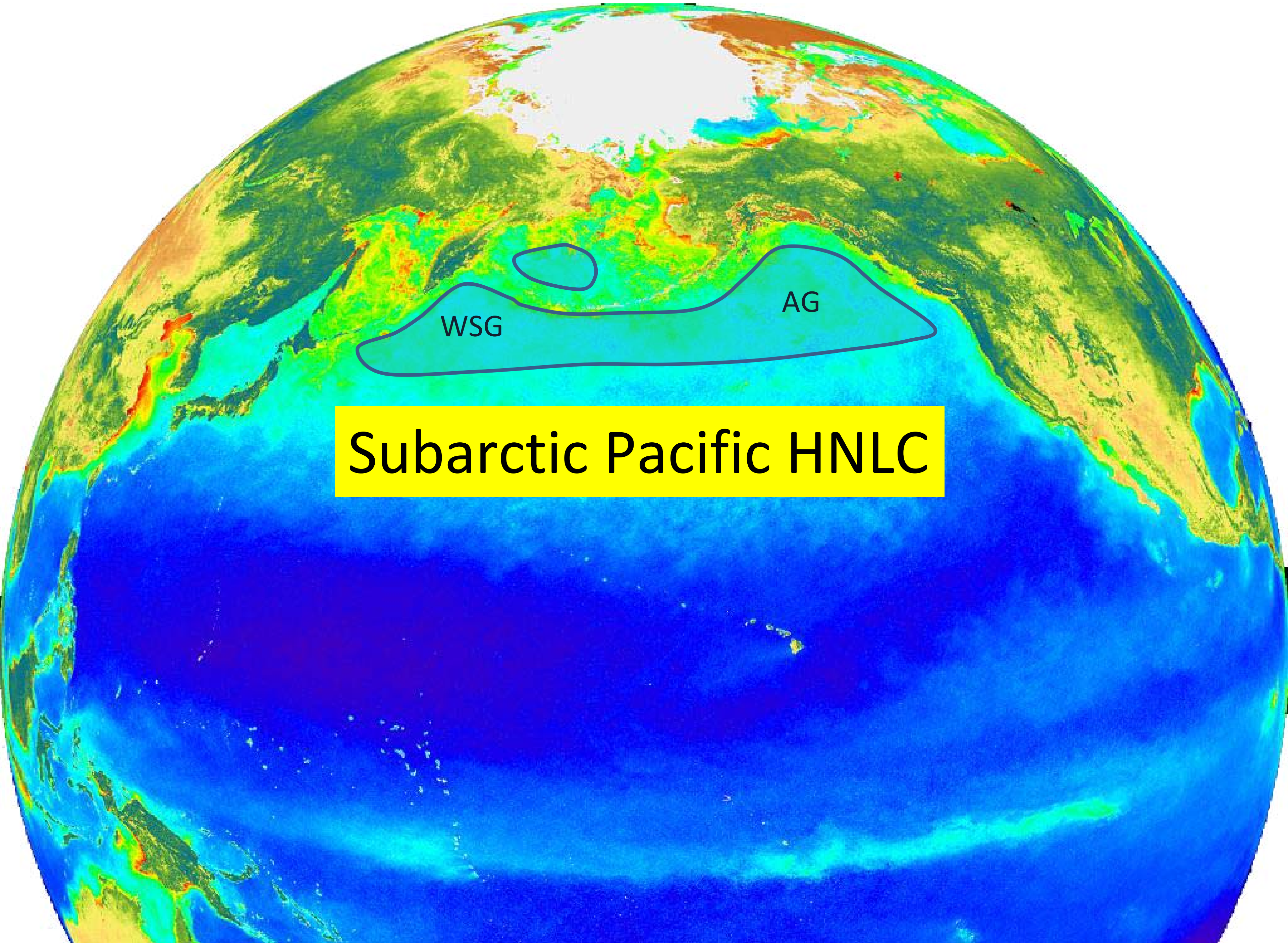
Hiroaki Tatebe	JAMSTEC

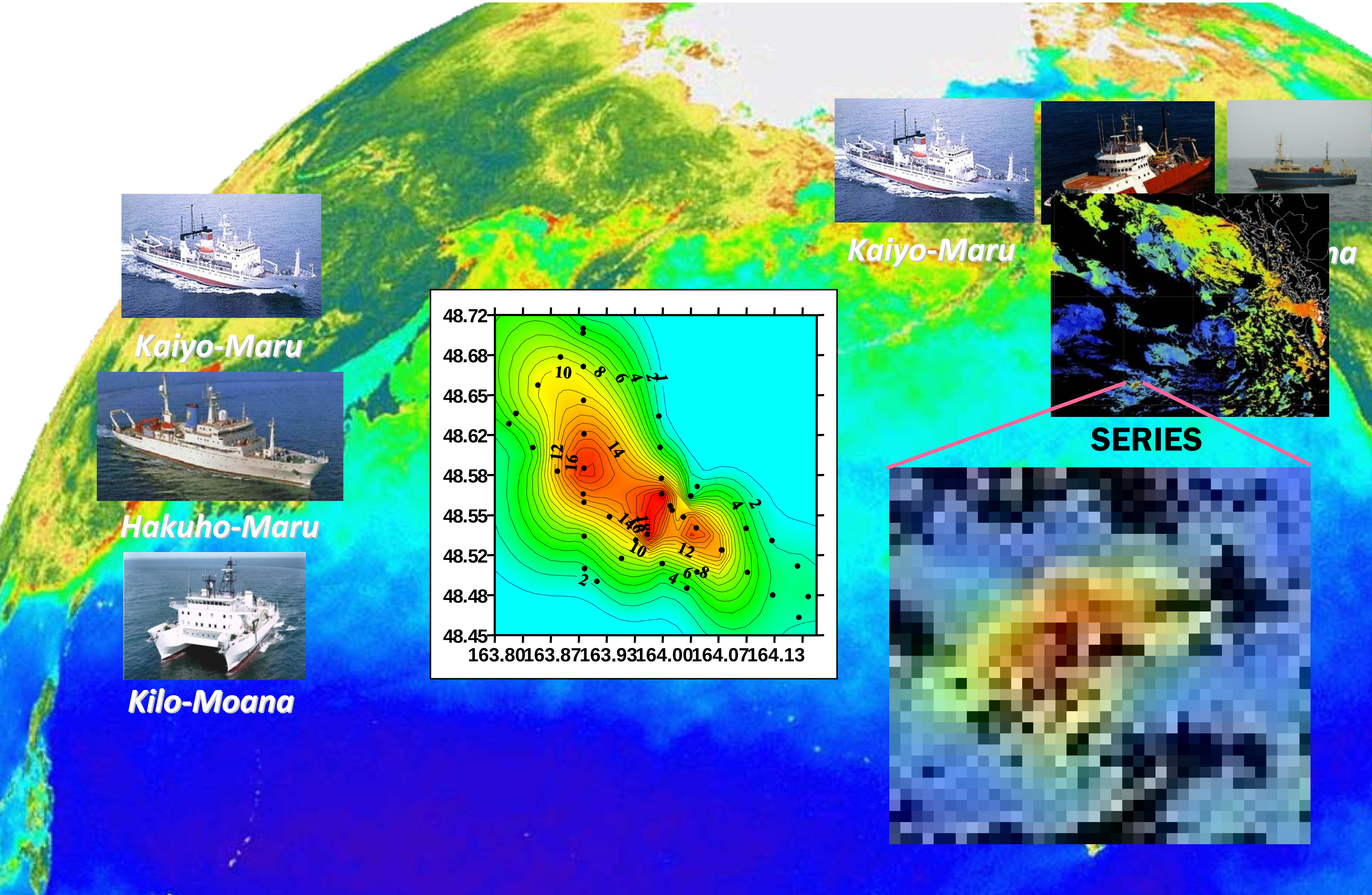
NO_3 at 0m

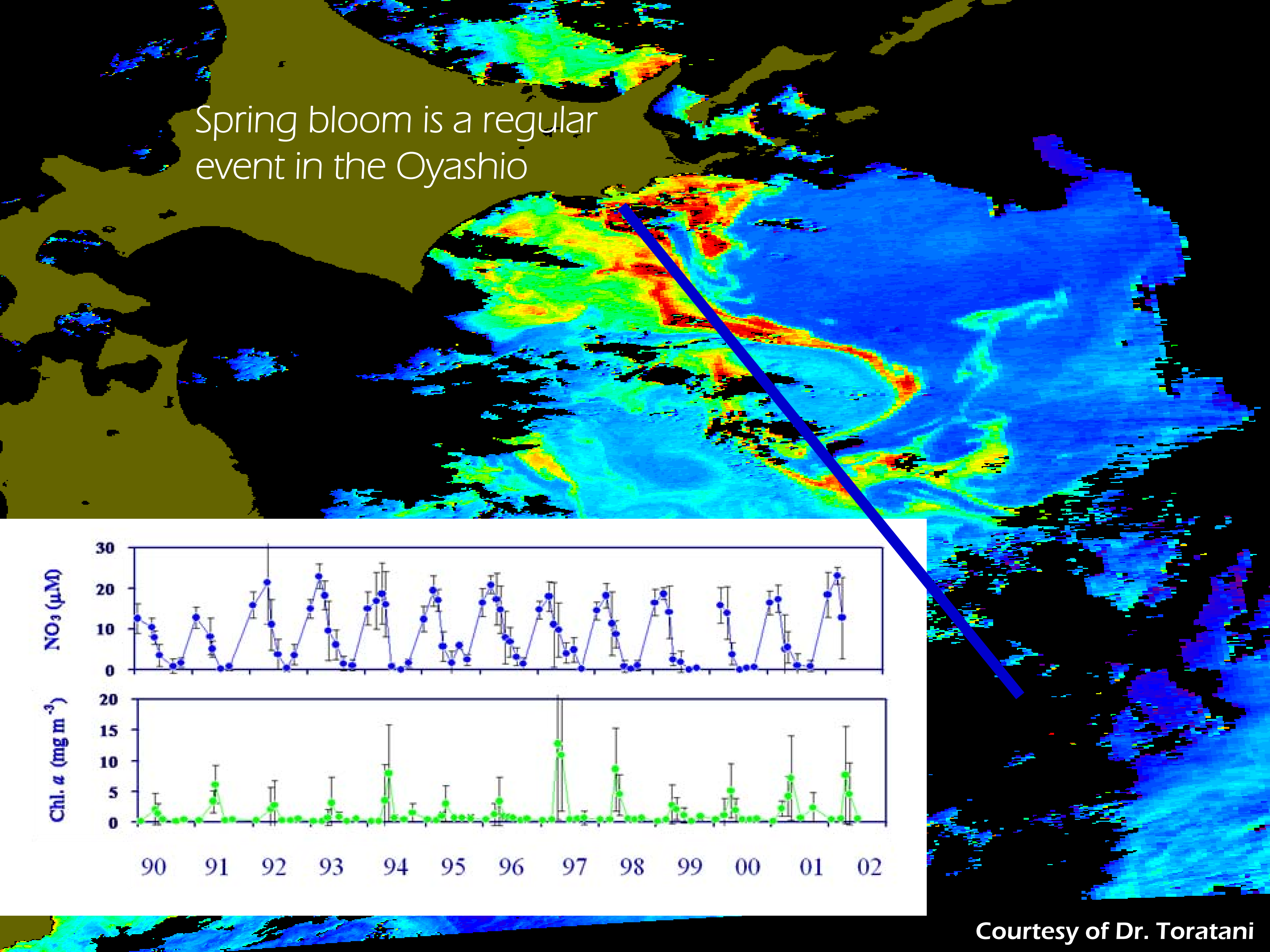


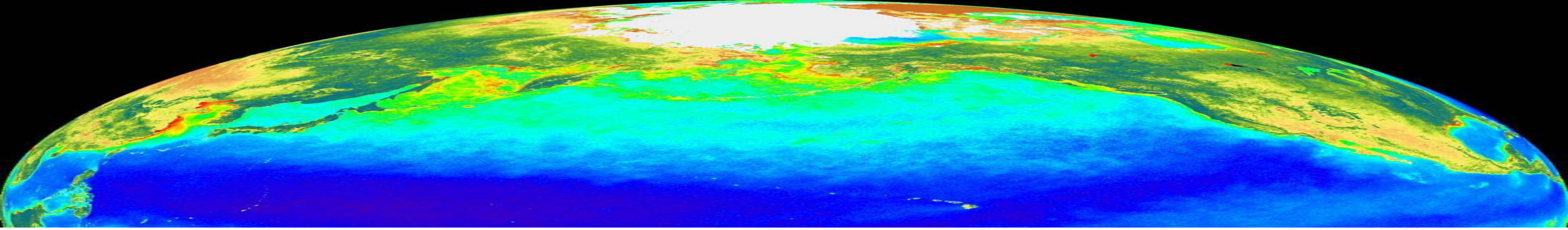
Sarmiento & Gruber 2006


WSG
AG
Subarctic Pacific HNLC

Iron Enrichment Exps

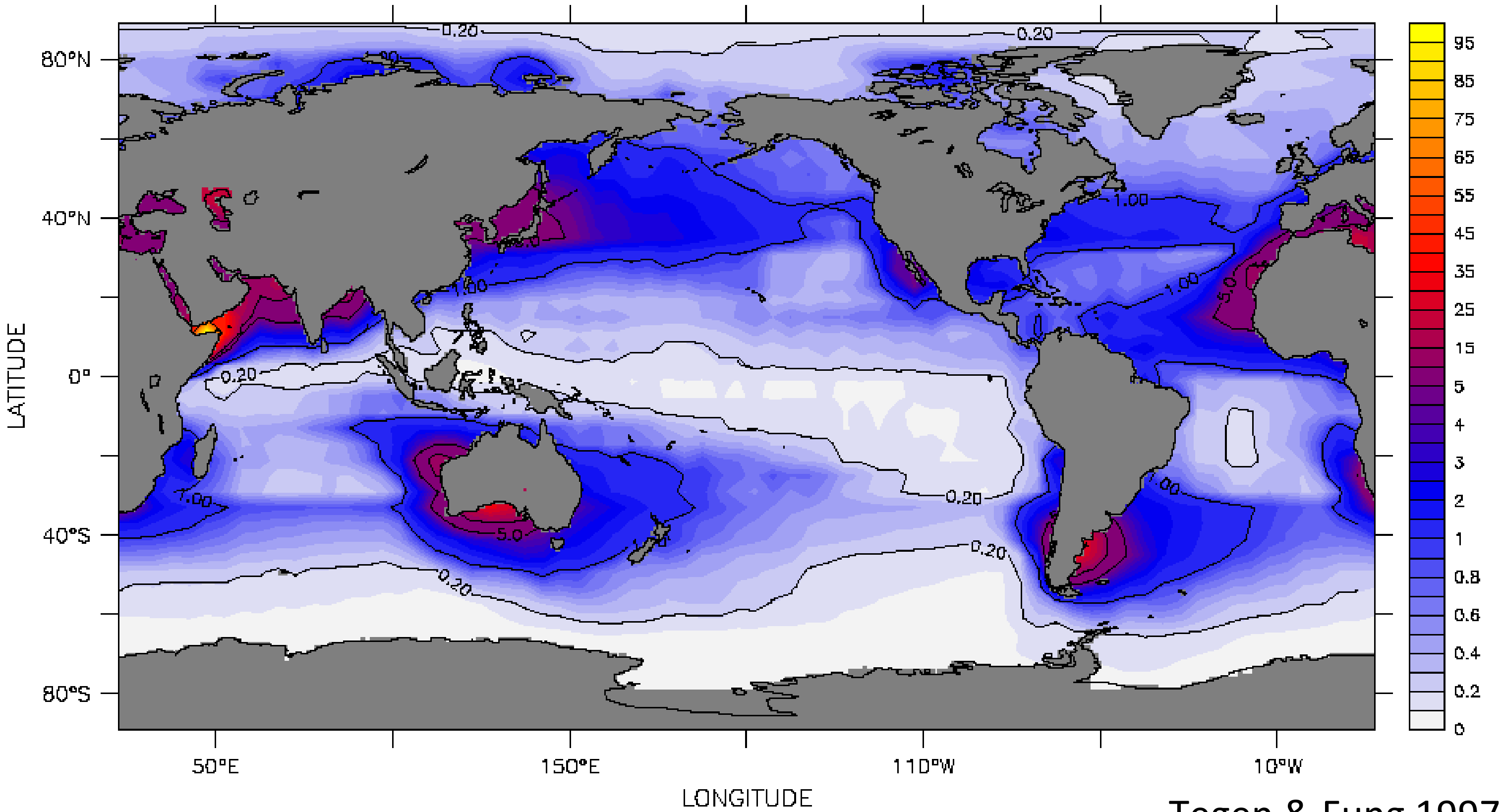



Spring bloom is a regular event in the Oyashio
NO3 (µM)
30
20
10
0
Chl. a (mg m-3)
20
15
10
5
0
90
91
92
93
94
95
96
97
98
99
00
01
02
Courtesy of Dr. Toratani



	Coastal (OY)	WSG	Alaskan Gyre
Dissolved Fe	<0.1-1.5 nM	<0.1 nM	<0.1 nM
ΔNO_3	15-20 μM	10-15 μM	8-10 μM
ΔBiol. pCO_2	ex. high	high	low
Balast	Opal	Opal	$CaCO_3$
Chl. in summer	0.5-2.0 mg m^{-3}	0.5-1.0 mg m^{-3}	0.3 mg m^{-3}
Phytopl	diatom, cyano., crypto.	diatom, green, cryptophyte	prymnesiophyte, cyanobacteria
Diatom	centric	centric	pennate
Zooplankton	large herbivore	large herbivore	large herbivore

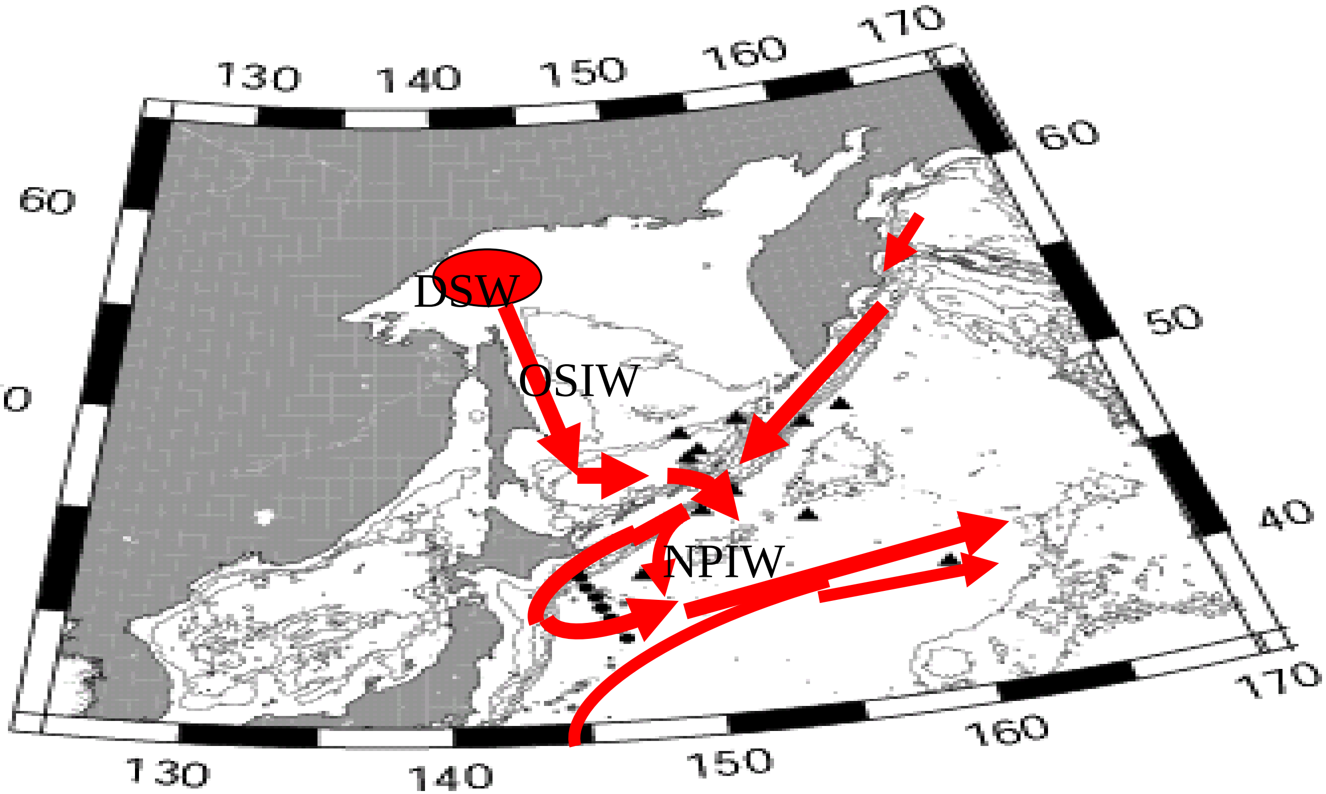
Dust Deposition



Tegen & Fung 1997

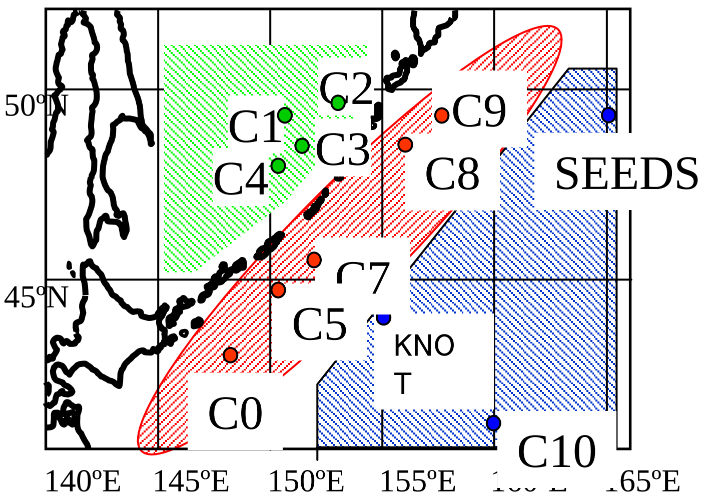
HNLC regions are the region of low dust flux

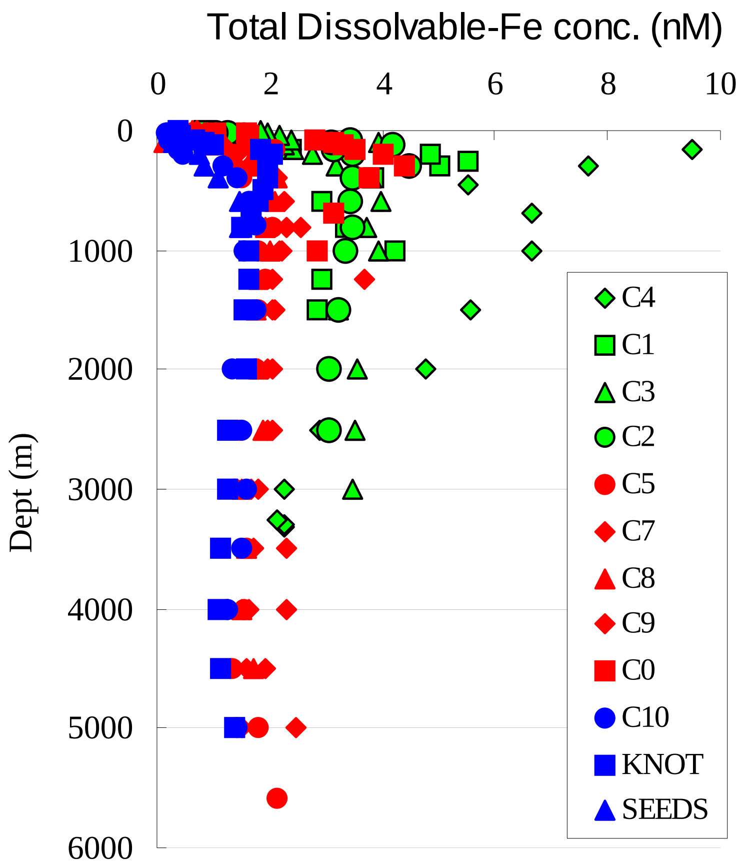
High-Fe High-Turbid Low-Temp water in subsurface layer



Materials are transported from the Sea of Okhotsk to WSP by the intermediate water transportation

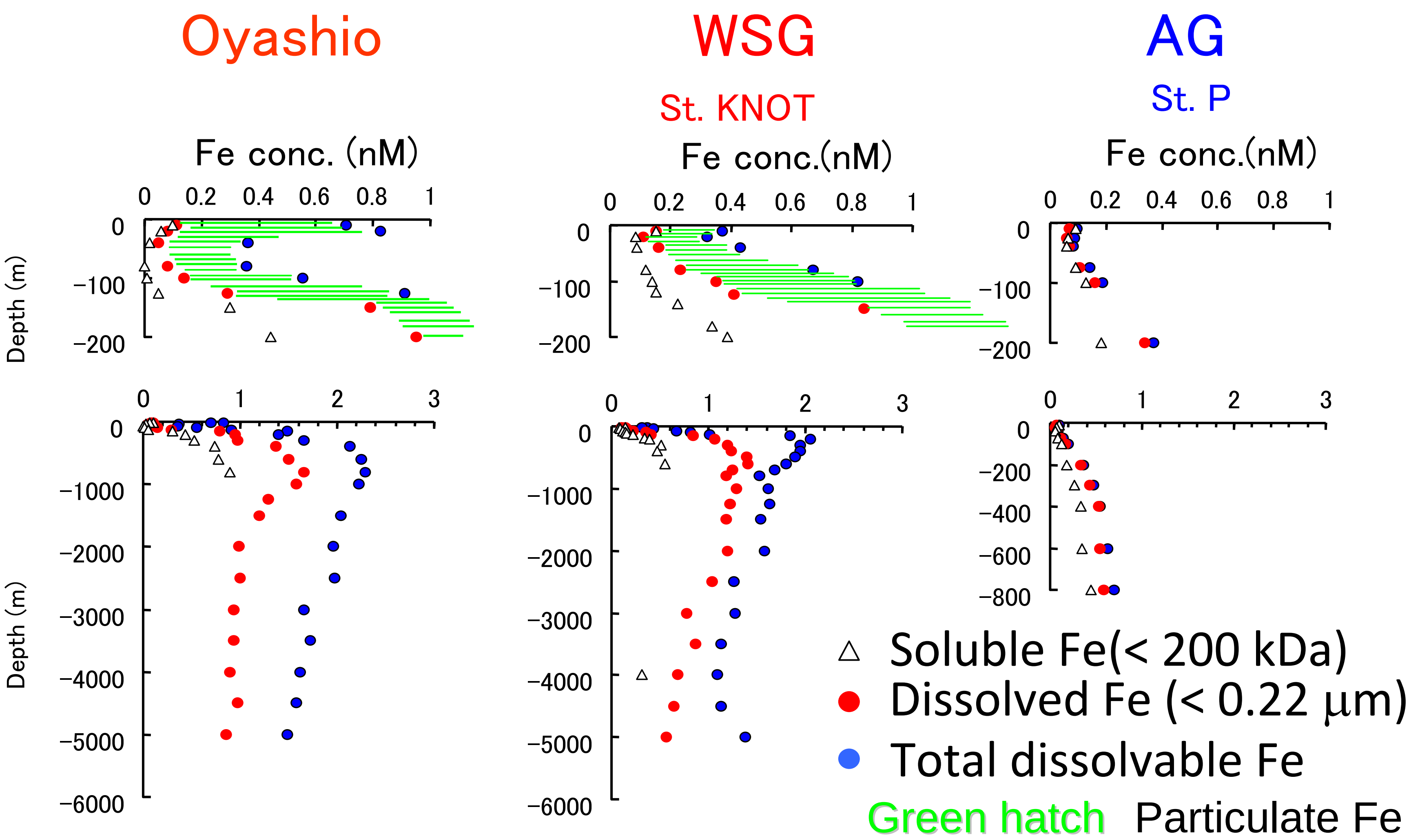
High Fe supply to the Oyashio region from the Sea of Okhotsk



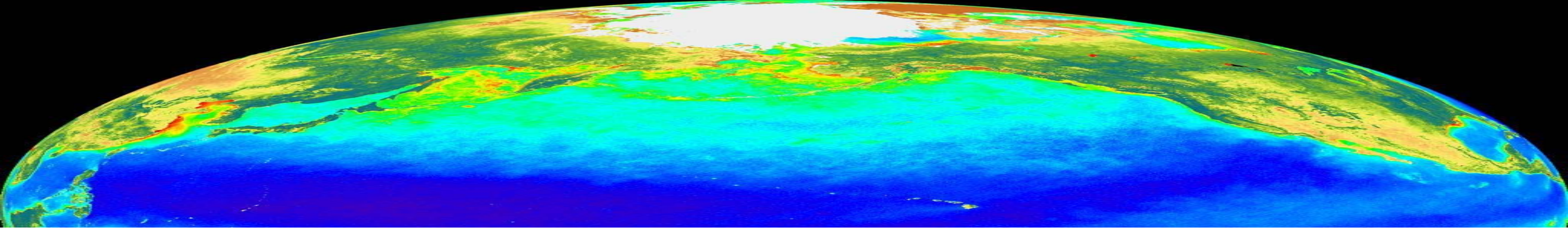


Higher Fe in the Oyashio than oceanic WSG
Most dust storms pass south of the Oyashio region
Distribution of high Fe water suggest the Sea of Okhotsk is the source region of Fe

Eastward decline in Fe concentration



High particulate Fe in the western subarctic Pacific



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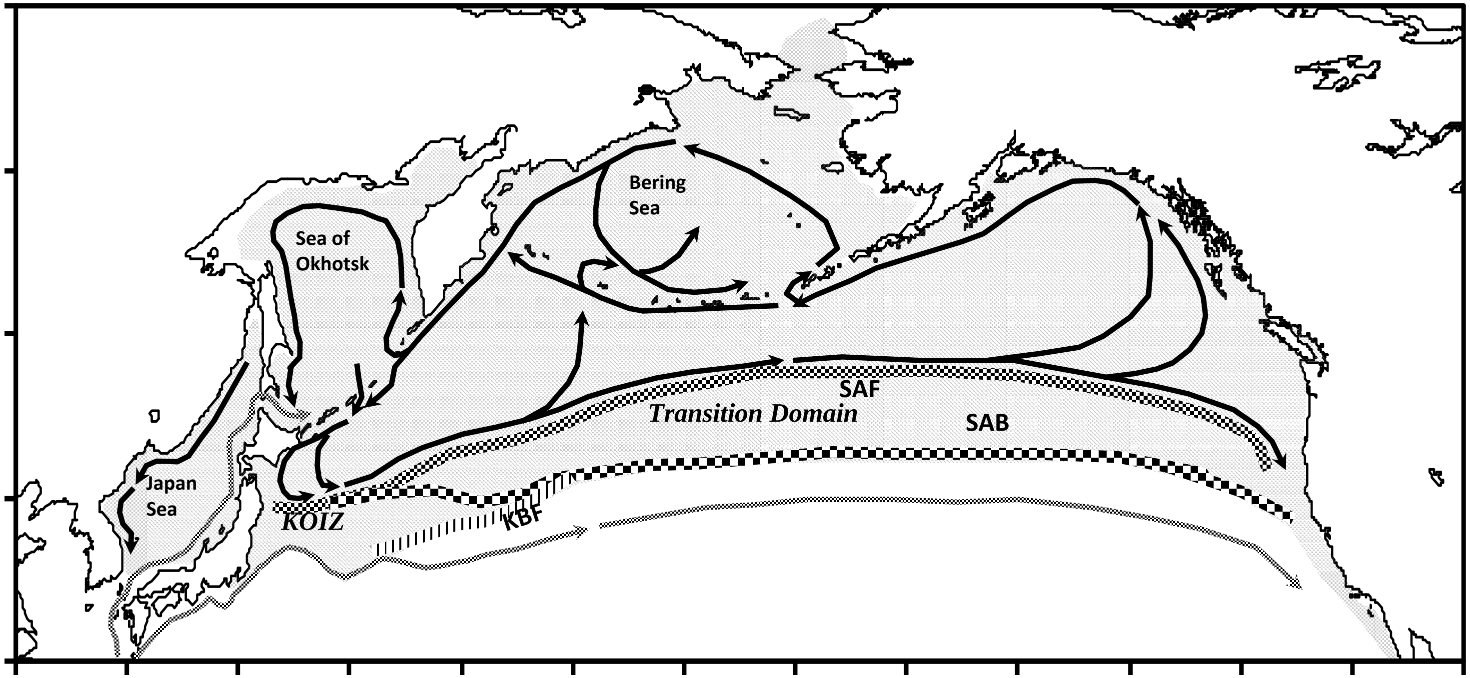
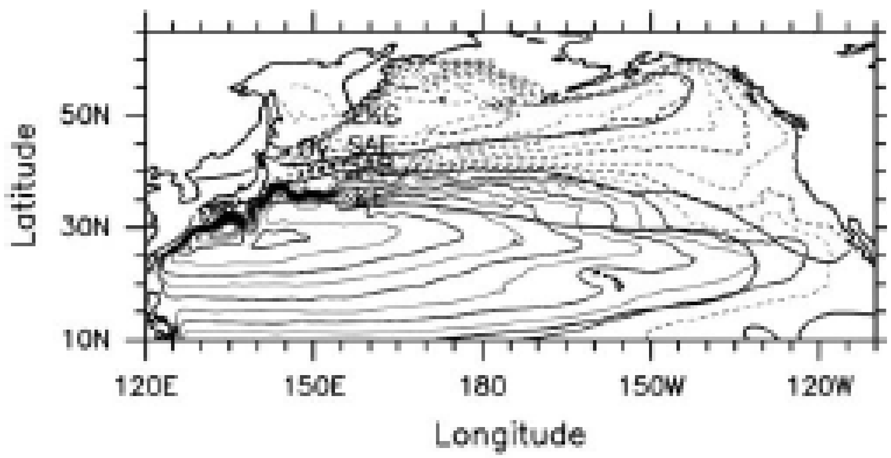
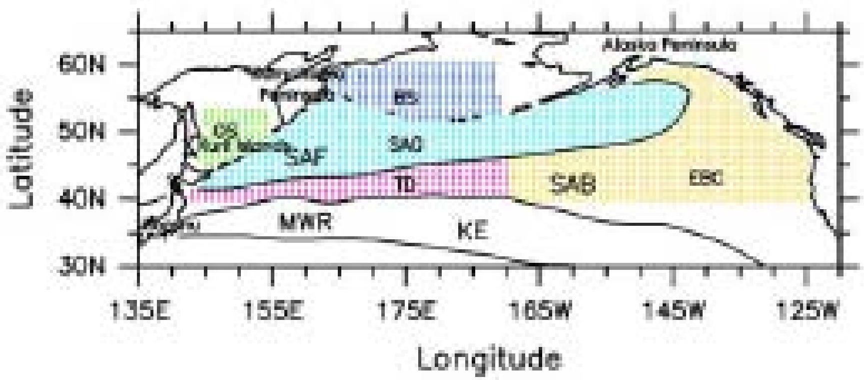
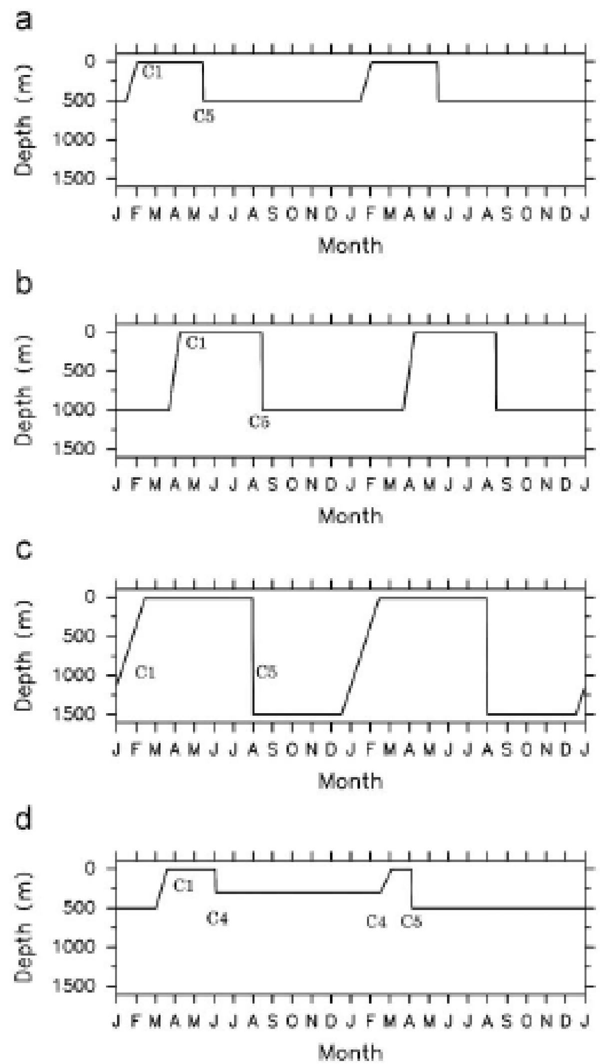
Neocalanus : distribution



Neocalanus transport IBM (Tatebe et al. 2010 DSRI)







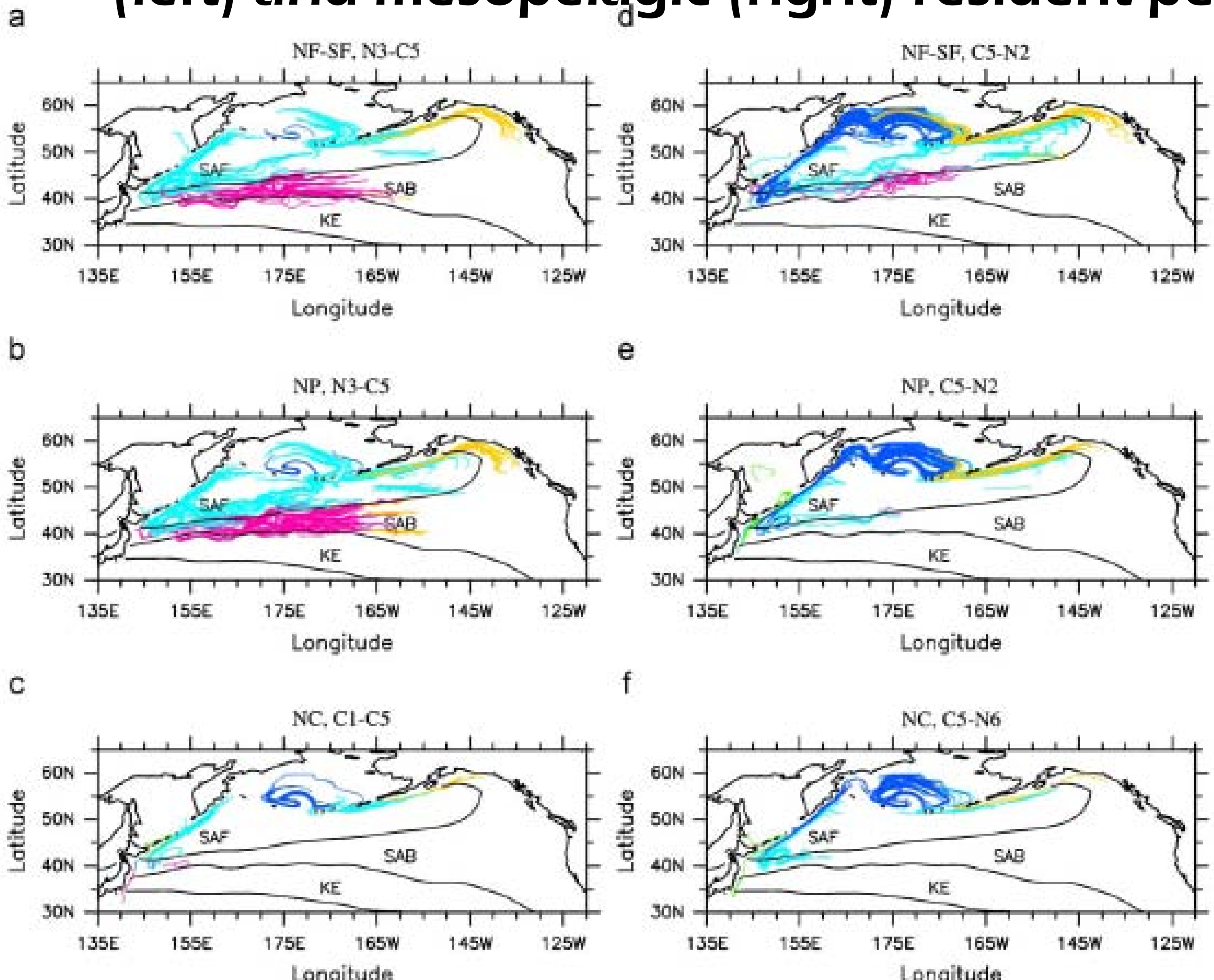
N. flemingeri
small form

N. plumchrus

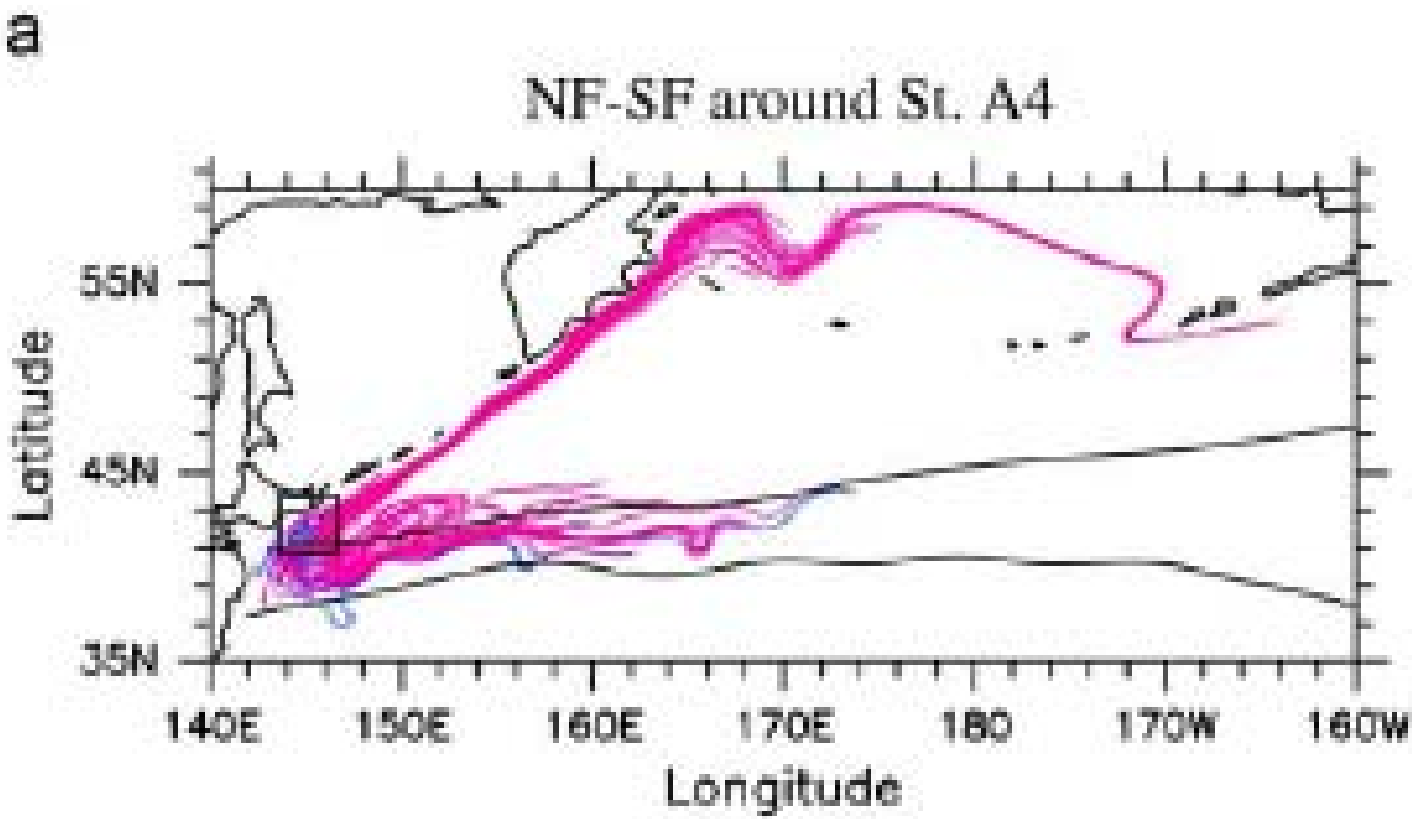
N. cristatus

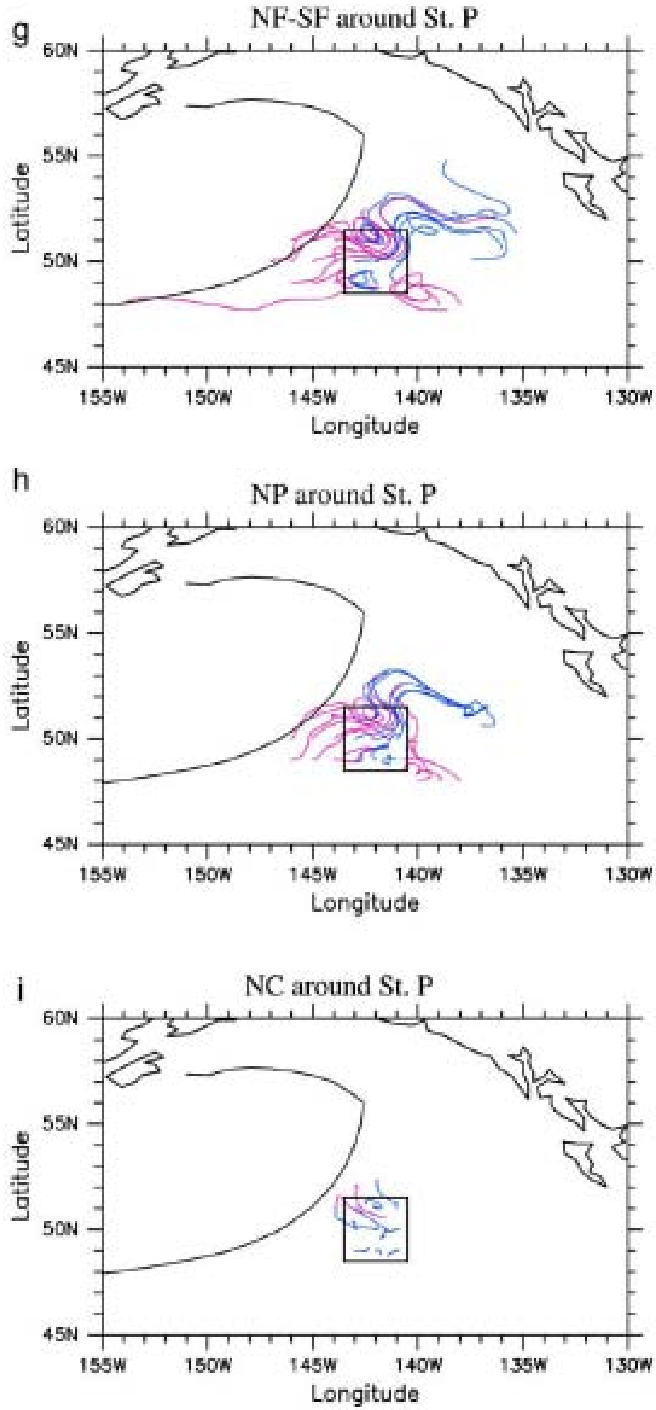
N. flemingeri
large form

Trajectories of *Neocalanus* during epipelagic (left) and mesopelagic (right) resident period



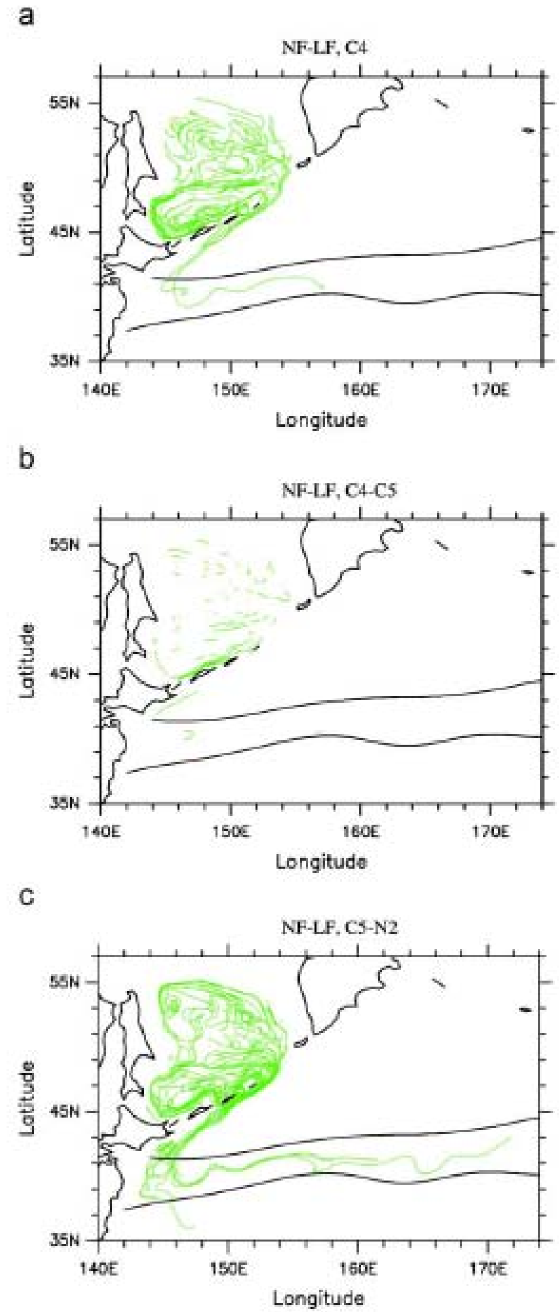
Trajectory of *N. flemingeri* through Oyashio region for one generation



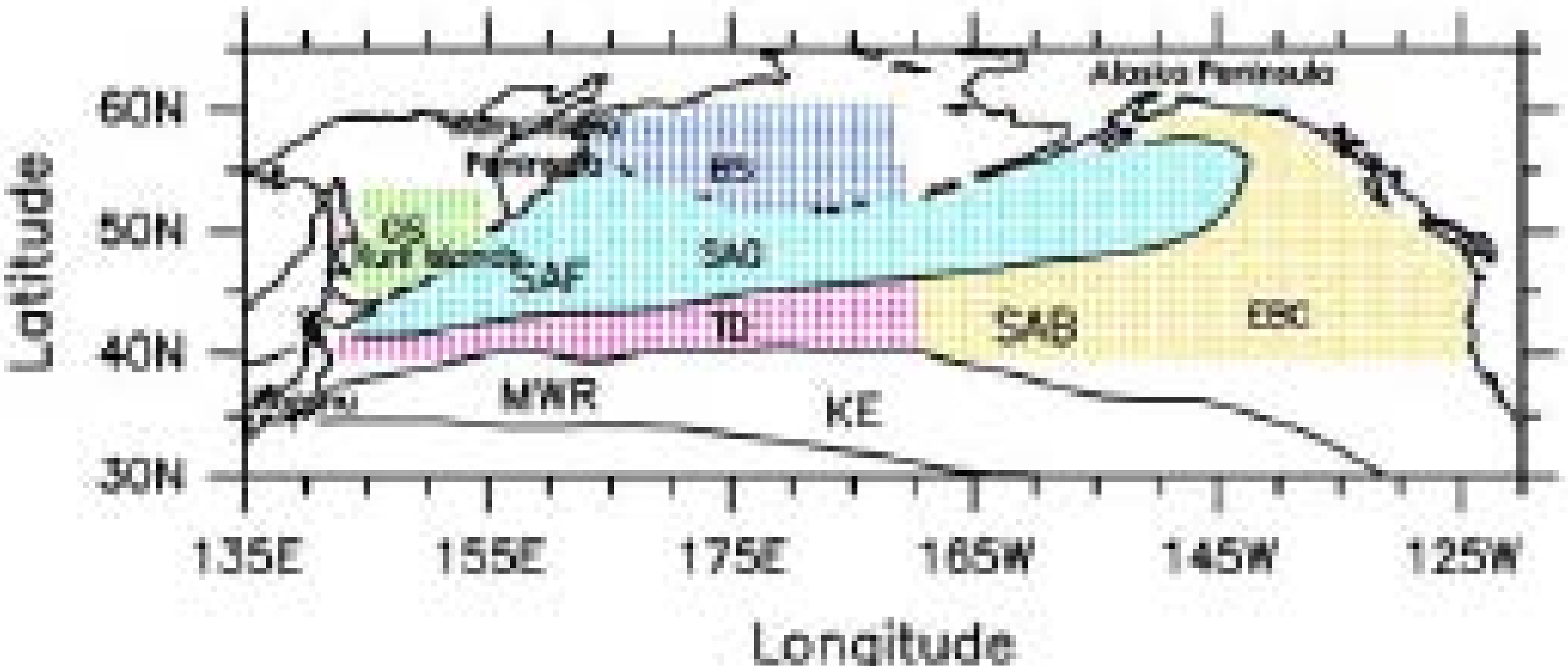

g
NF-SF around St. P
60N
55N
50N
45N
Latitude
155W
150W
145W
140W
135W
130W
Longitude
h
NP around St. P
60N
55N
50N
45N
Latitude
155W
150W
145W
140W
135W
130W
Longitude
i
NC around St. P
60N
55N
50N
45N
Latitude
155W
150W
145W
140W
135W
130W
Longitude

N. flemingeri large form

LF occur in the Sea of Okhotsk, having 2-years life cycle



Subarctic front

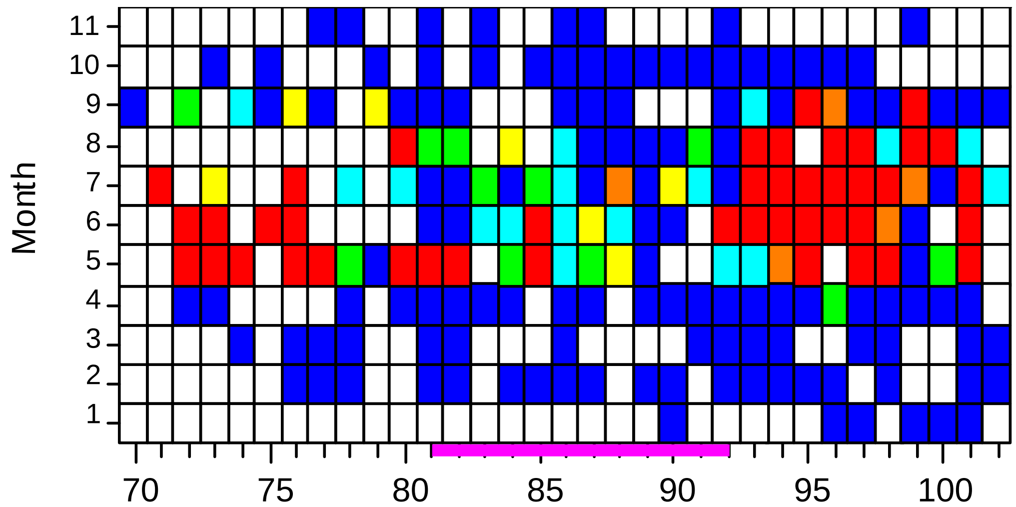


Alaska Peninsula
60N
50N
40N
30N
Latitude
SAF
SAG
TD
SAB
MWR
KE
135E
155E
175E
165W
145W
125W
Longitude

Intra- and inter-areal transport ratios (%) per generation.

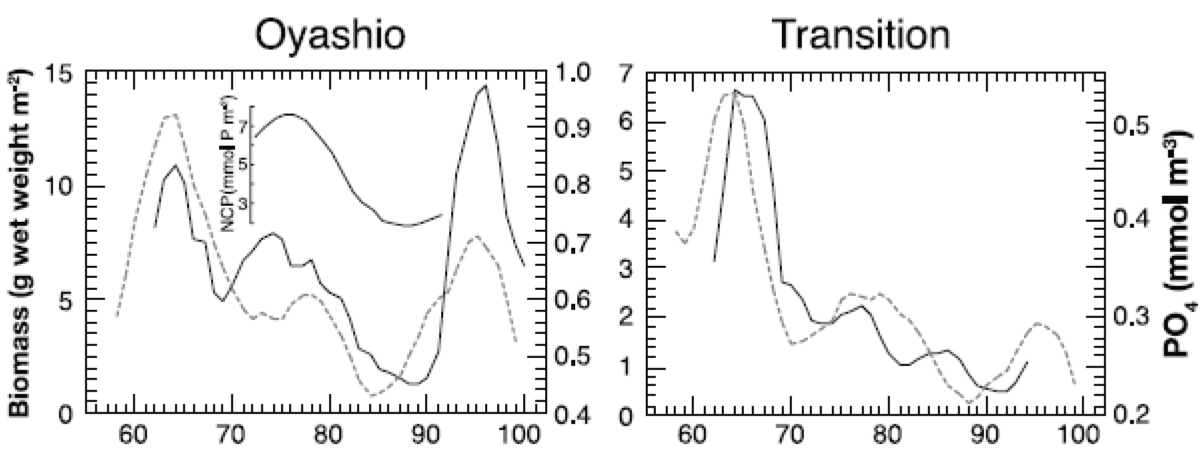
From/to	TD	SAG	OS	BS	EBC	AS40
(a) *N. flemingeri* (small form)						
TD [177]	36	18	0	0	38	8
SAG [518]	4	76	1	14	5	0
BS [174]	9	25	0	64	0	2
EBC [511]	0	7	0	5	72	16
(b) *N. plumchrus*						
TD [177]	30	26	0	0	37	7
SAG [518]	3	77	1	13	6	0
OS [74]	3	4	86	0	0	7
BS [174]	3	16	1	80	0	0
EBC [511]	0	7	0	3	76	14
(c) *N. cristatus*						
TD [177]	69	11	0	0	10	10
SAG [518]	4	84	1	7	4	1
OS [74]	0	5	90	0	0	4
BS [174]	1	12	0	87	0	0
EBC [511]	0	5	0	0	88	7
(d) *N. flemingeri* (large form)						
OS [74]	11	4	82	0	0	3

N.plumchrus in the Oyashio



Tadokoro (unpublished)

N. plumchurus (5-year running mean)



Tadokoro et al. 2009 GRL

Conclusions

- A part of regional *Neocalanus* population exchange with other populations by passive transport. This is consistent with the low genetic variability of *Neocalanus*

- The transportation distance is longer for *Neocalanus* distributed along the Oyashio, SAB, Alaskan stream than one in the central gyre, such as St.Papa.

- *Neocalanus* and the zooplankton with long life cycle (~1 years) play the role of reserving organic matter (buffering seasonality in primary production) and transporting to the other ocean domain (buffering horizontal heterogeneity of primary production).

Conclusions

- Year-to-year variability of the current system influence the biomass of zooplankton at a geographically fixed station as well as the productivity.
  - Significant fraction of *Neocalanus* (10-64%) are transported to the other domains.
  - 0-14% of *Neocalanus* are transported to the south of 40°N (one way transport).

Future study: For the examination of long-term change in the biomass and species composition of zooplankton, we need to consider the change in the current system and water (zooplankton) transportation, e.g., examination of 3-D IBM with *Neocalanus* bioenergetics (C or N) using NCEP wind.