Sea-ice dispersal and source influence productivity patterns in the northern Bering Sea

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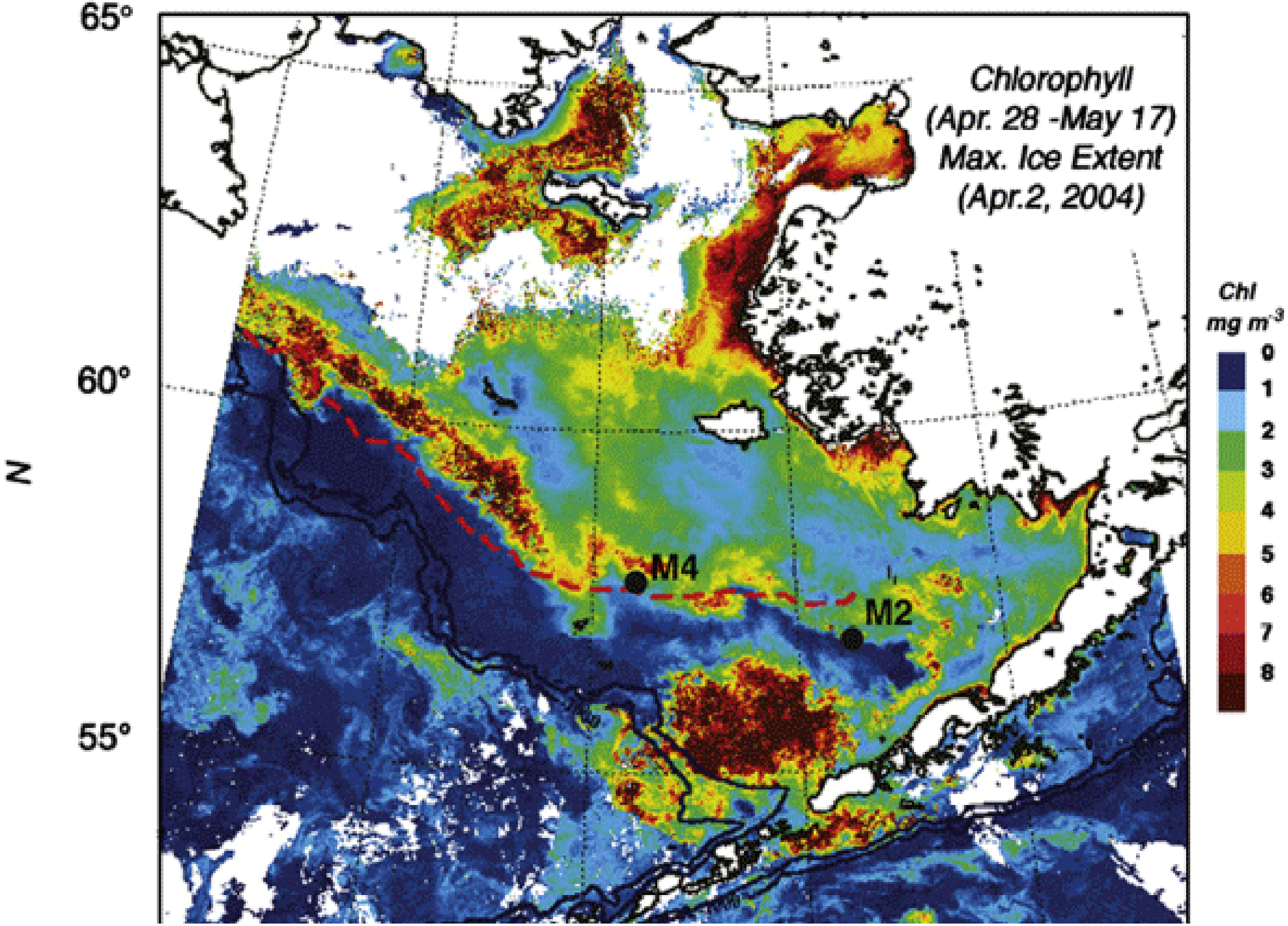
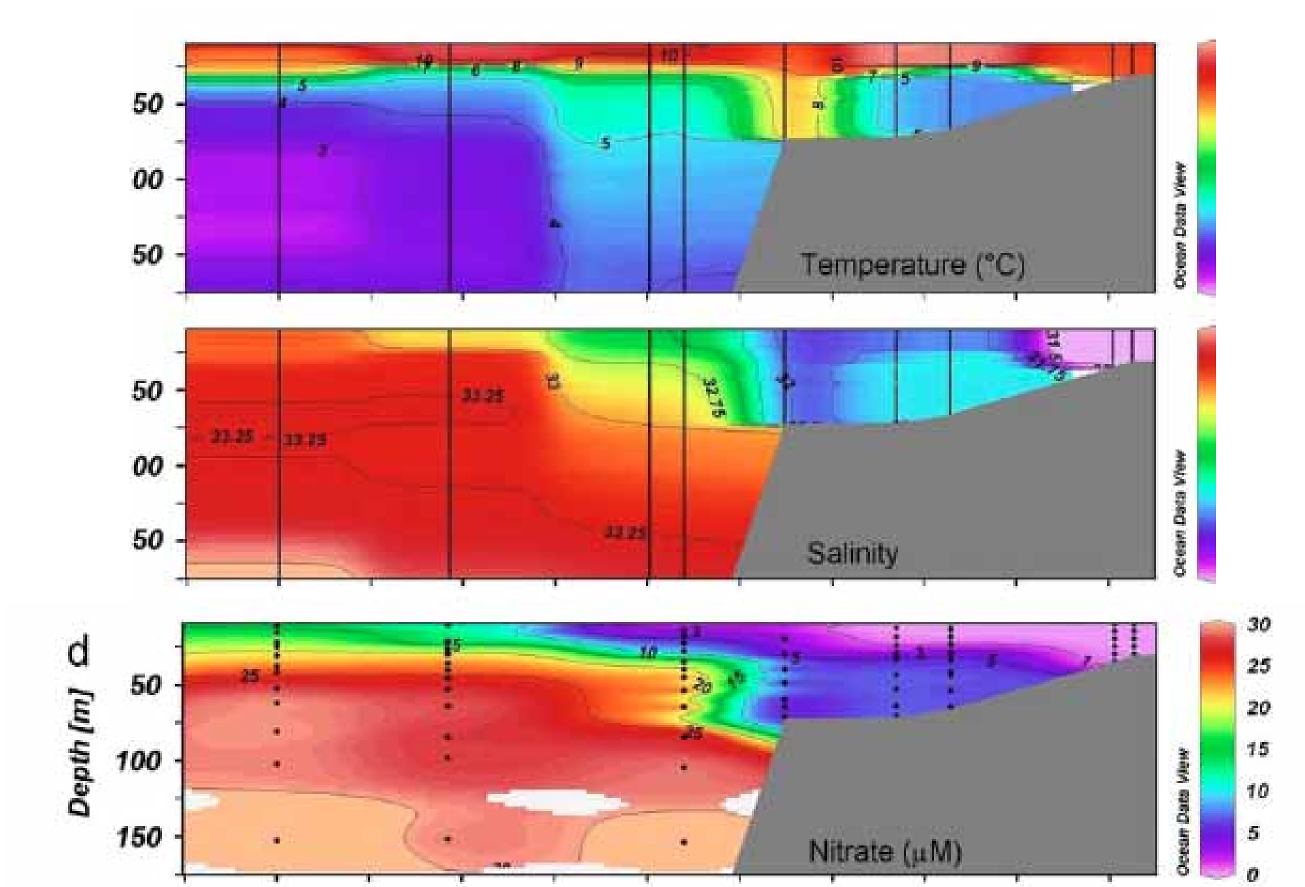
Spring production reflects pattern of sea-ice

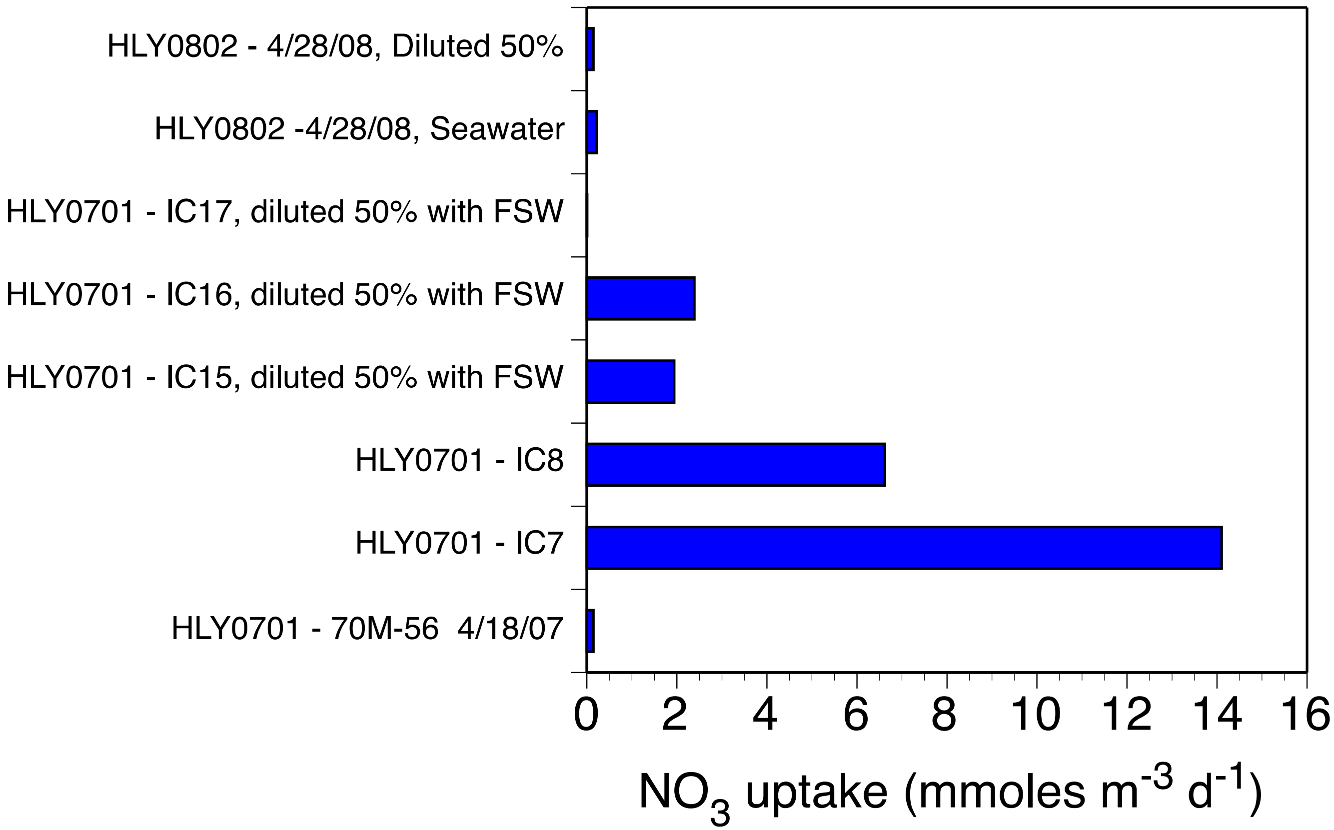


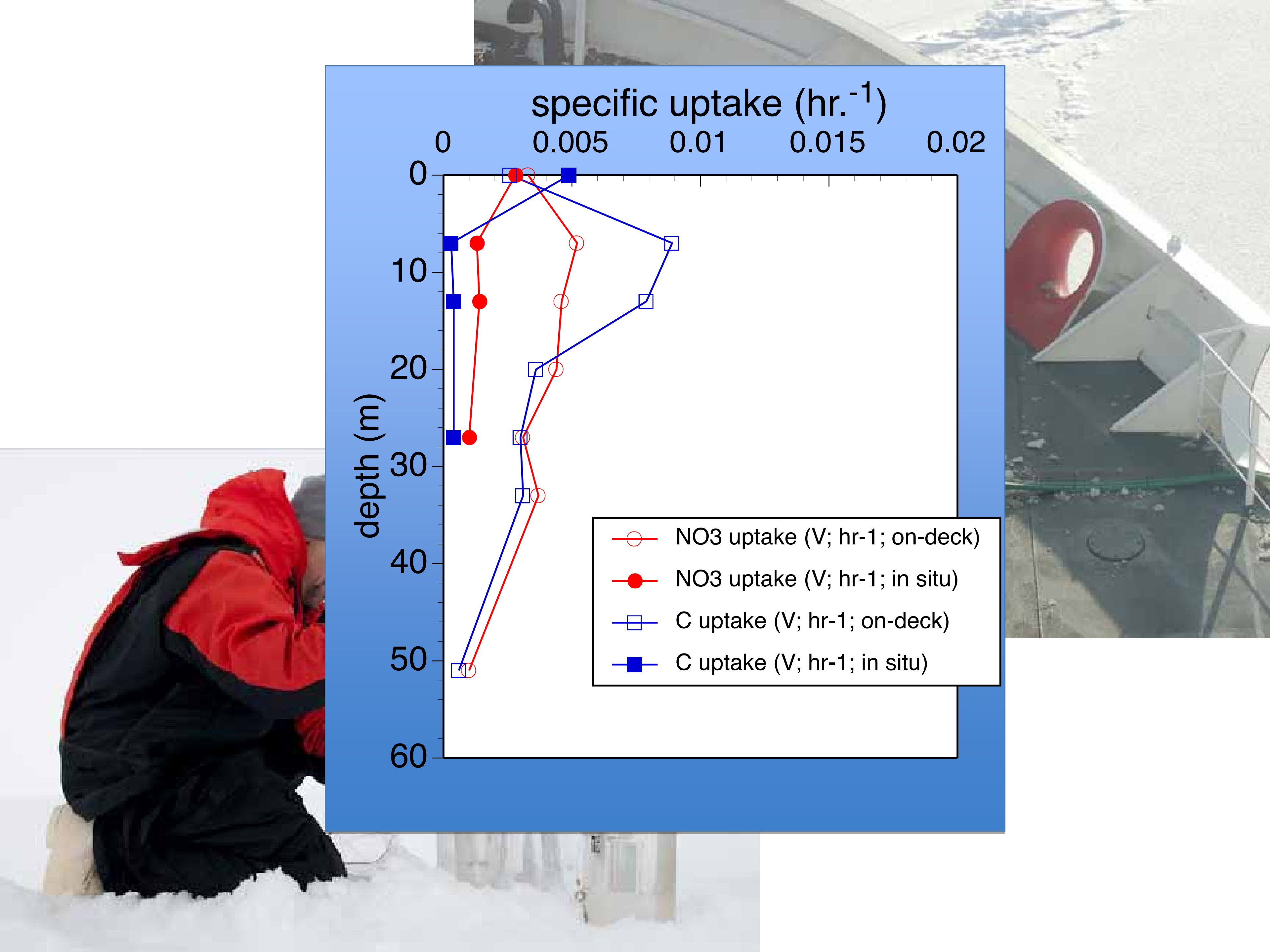
Ice from shelf is limited by warmer, saltier water off shore

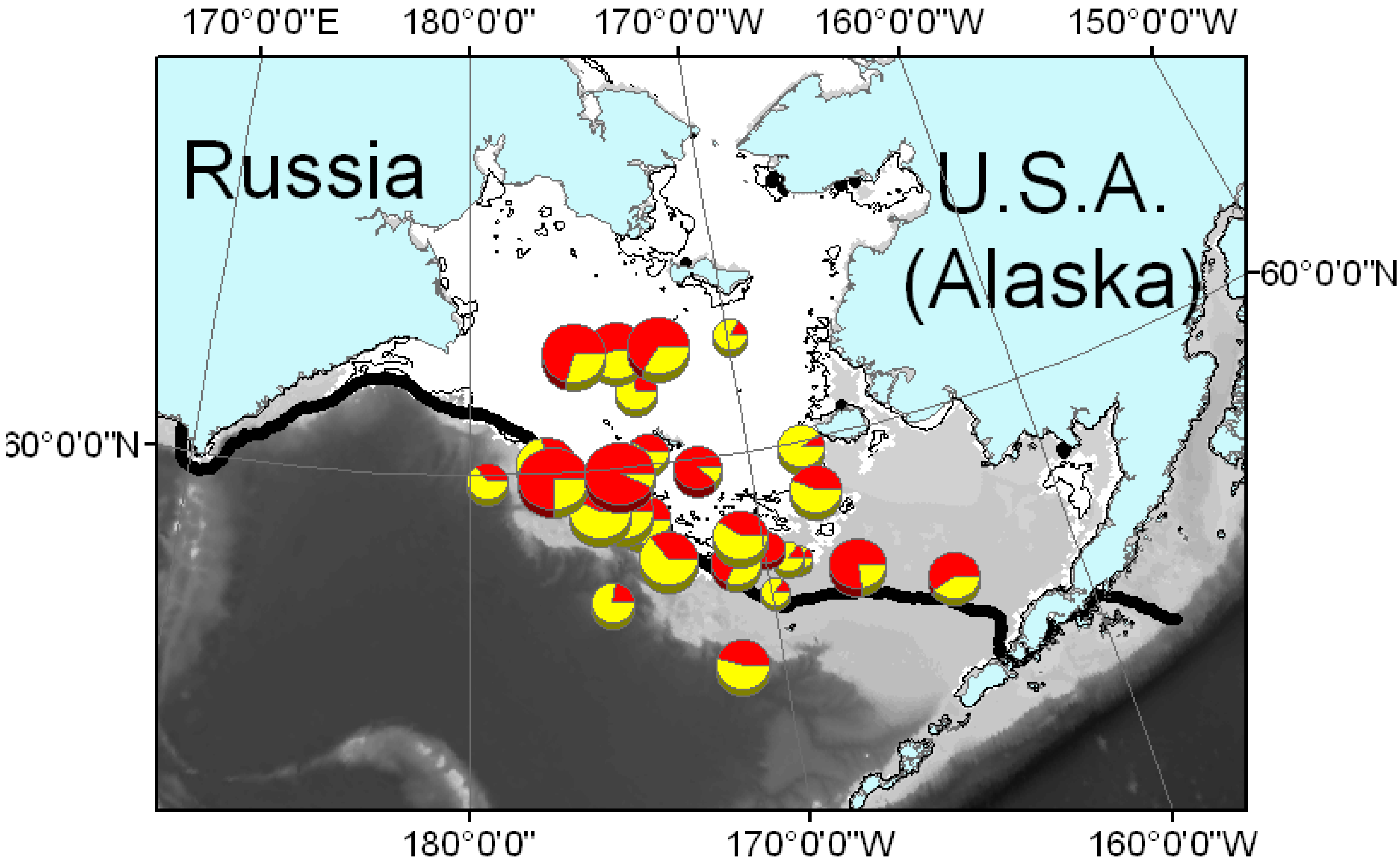


Typical ship track

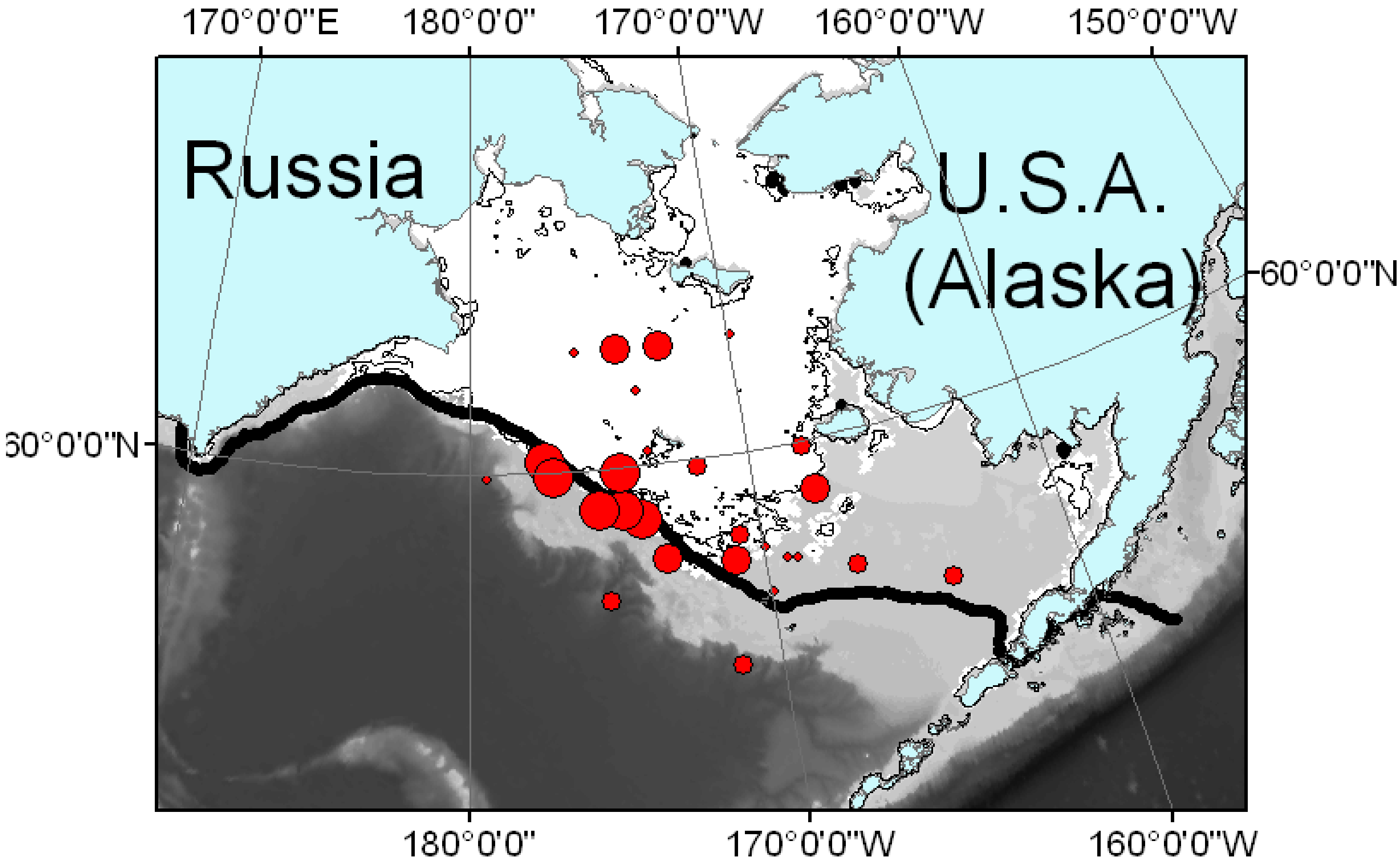
Various experimental approaches used to measure productivity of ice-algae





specific uptake (hr.$^{-1}$)
0
0.005
0.01
0.015
0.02
depth (m)
0
10
20
30
40
50
60
NO3 uptake (V; hr-1; on-deck)
NO3 uptake (V; hr-1; in situ)
C uptake (V; hr-1; on-deck)
C uptake (V; hr-1; in situ)



170°0'0"E
180°0'0"
170°0'0"W
160°0'0"W
150°0'0"W
Russia
U.S.A.
(Alaska)
60°0'0"N
60°0'0"N
180°0'0"
170°0'0"W
160°0'0"W



170°0'0"E
180°0'0"
170°0'0"W
160°0'0"W
150°0'0"W
Russia
U.S.A.
(Alaska)
60°0'0"N
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180°0'0"
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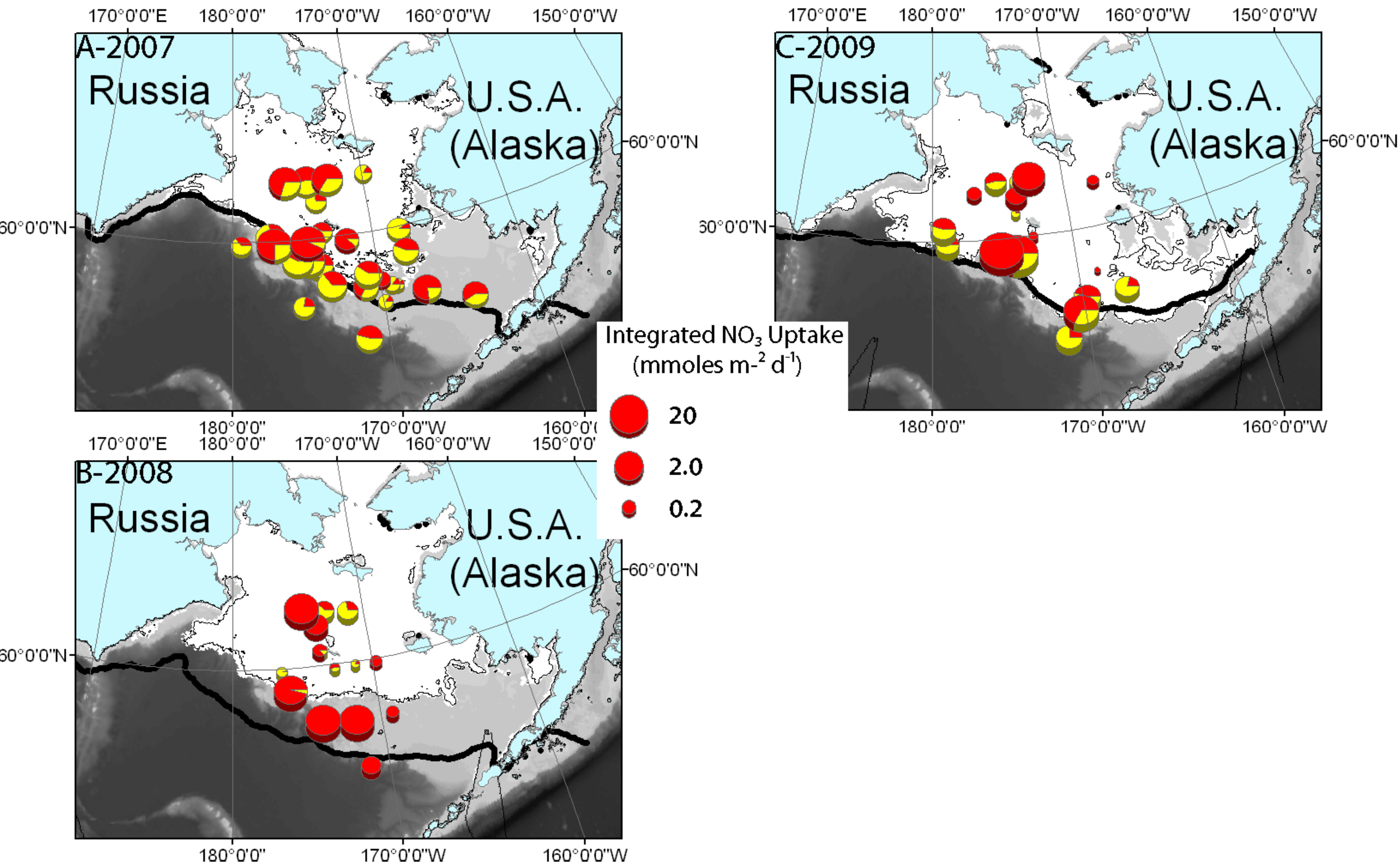
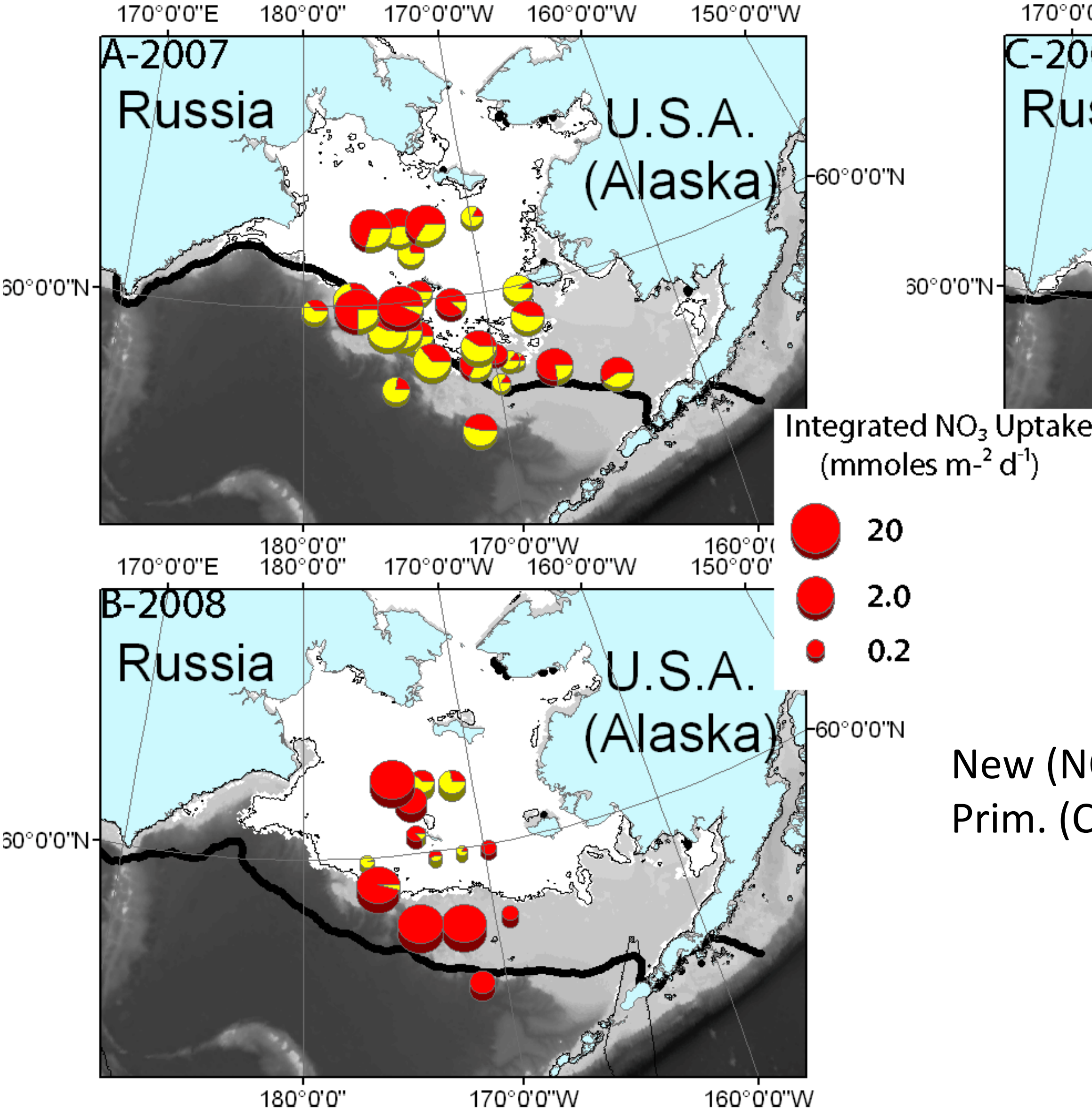
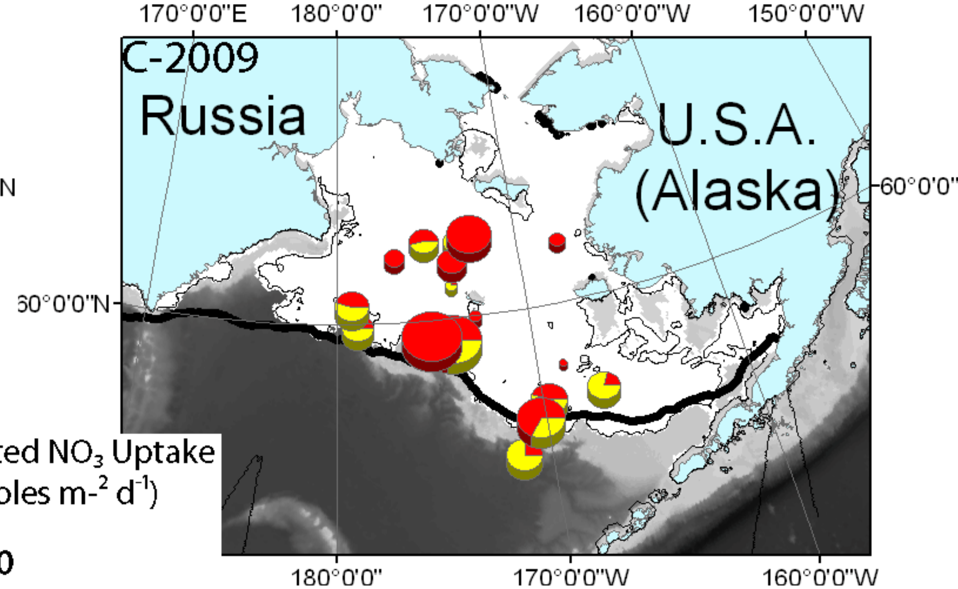
160°0'0"W



A-2007
B-2008
C-2009
Russia
U.S.A.
(Alaska)
170°0'0"E
180°0'0"
170°0'0"W
160°0'0"W
150°0'0"W
60°0'0"N
Integrated NO3 Uptake
(mmoles m-2 d-1)
20
2.0
0.2



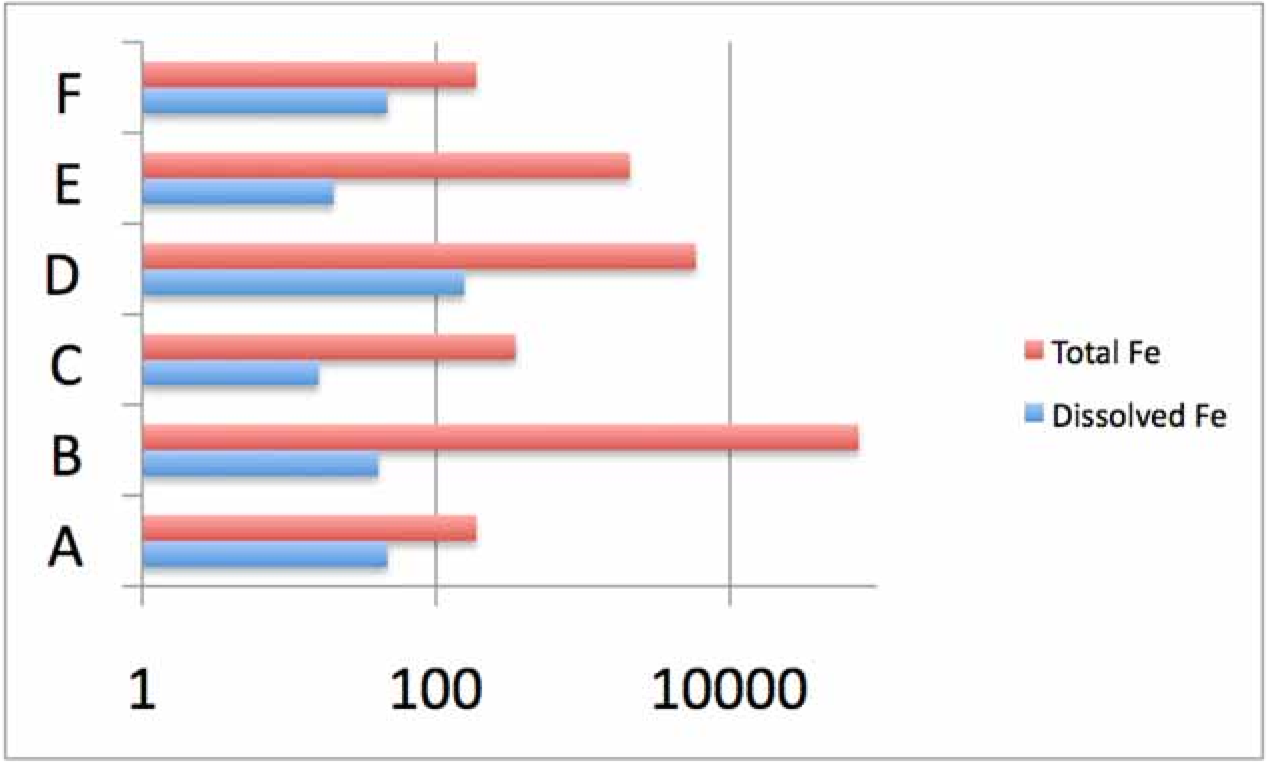


	Median	New>20	Prim.> 1
New (NO_3)	0.9	13%	
Prim. (C)	0.1		21%

Sea-ice impacts on productivity

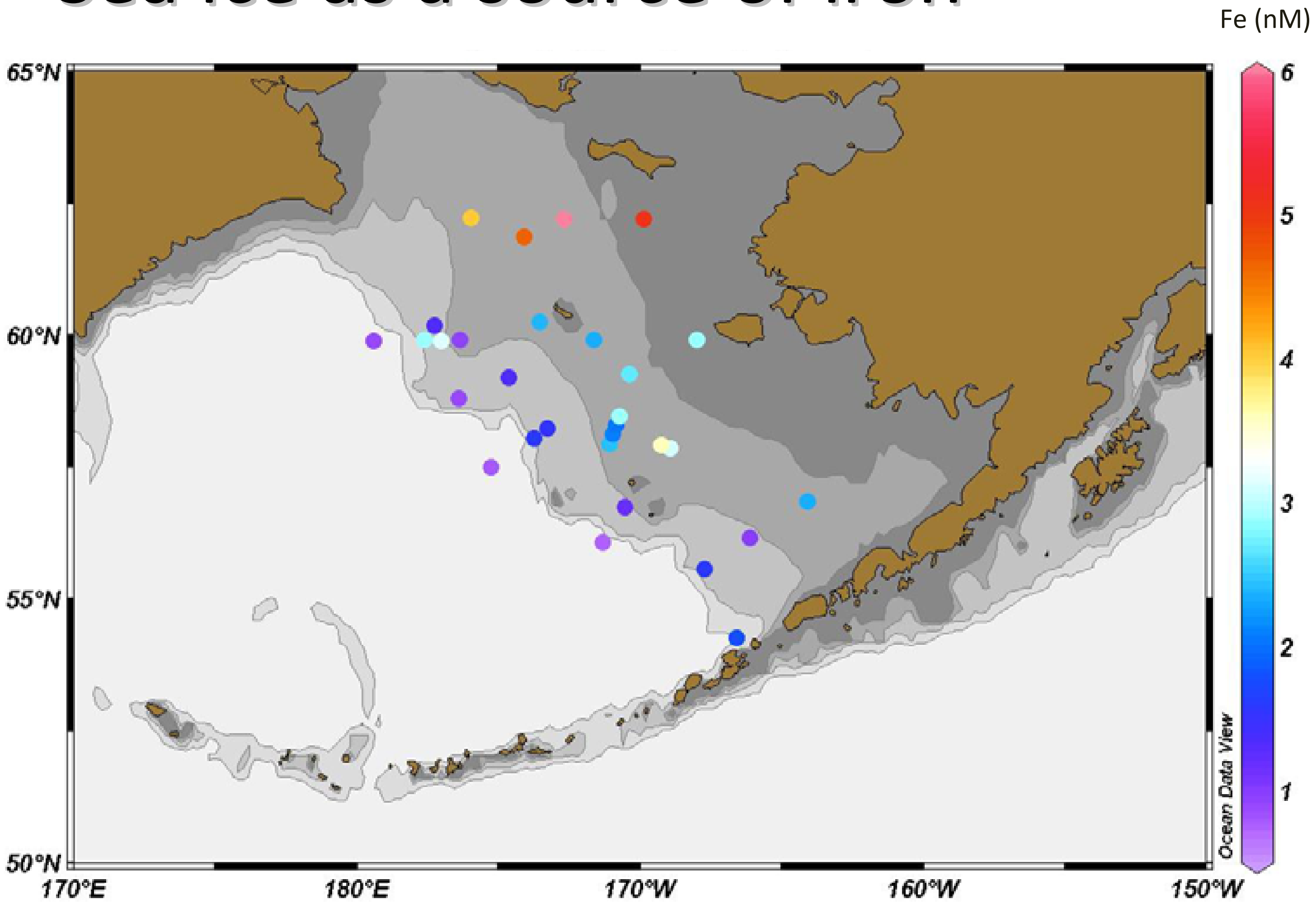
- Provides an environment for algal growth in sea ice brine channels
- Ice melt layer stabilizes upper water column and improves light conditions for growth
- Ice algae released into melt layer provide seed population for the plankton bloom.

Ice transports significant Fe



Based on Anguilar-Islas et al., 2008

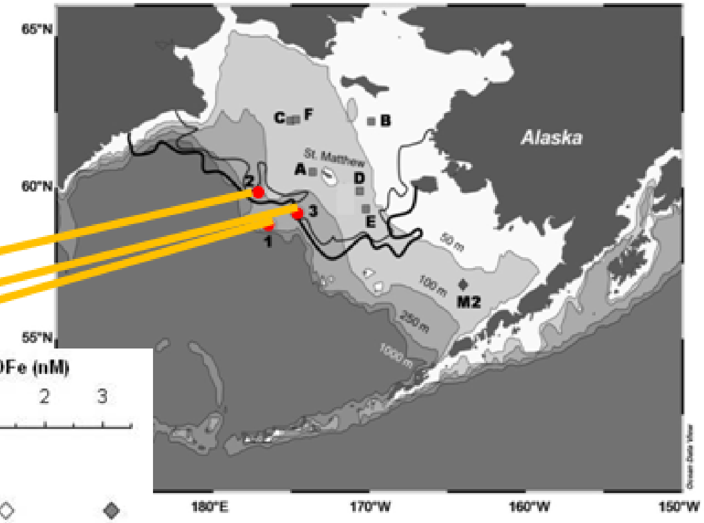
Sea ice as a source of iron

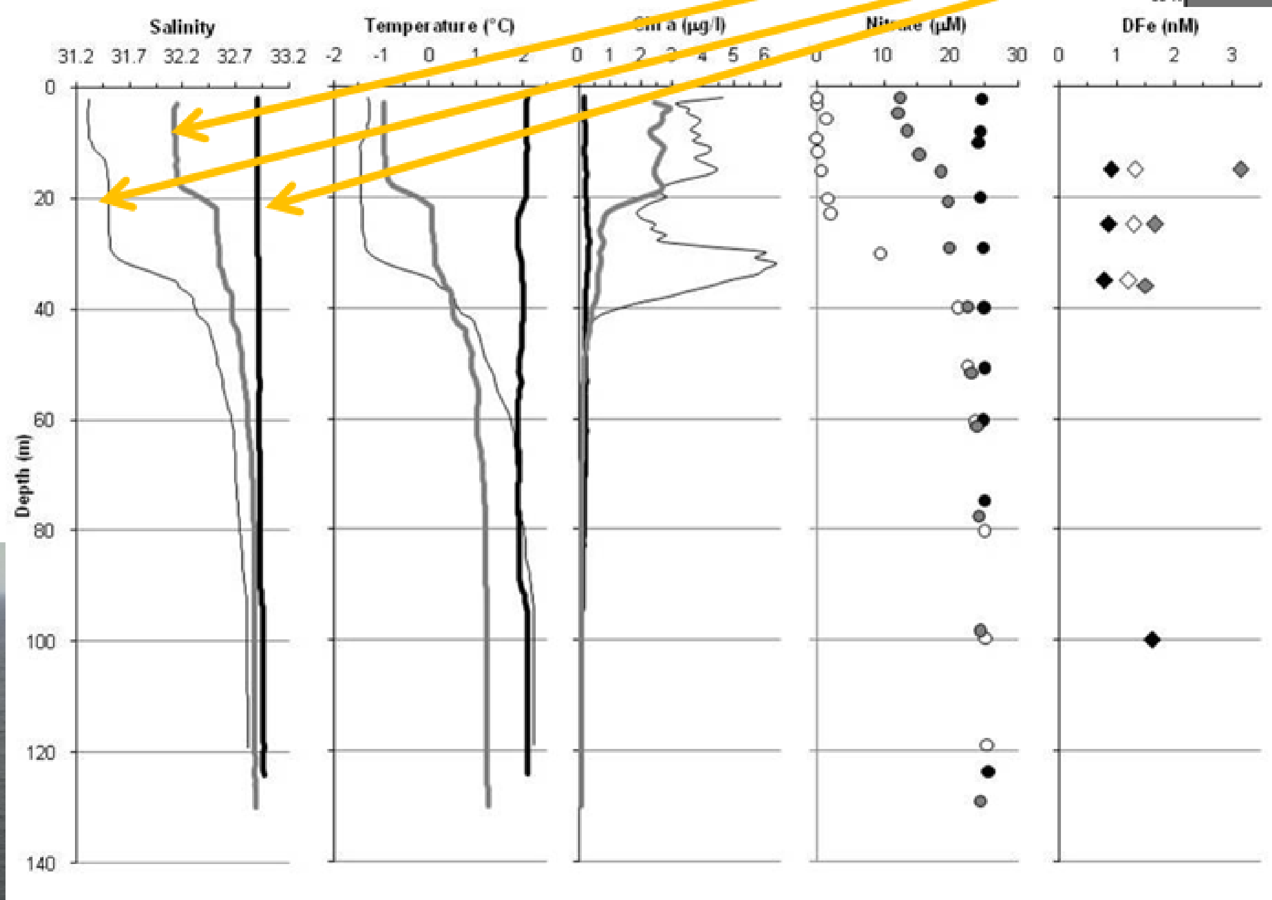


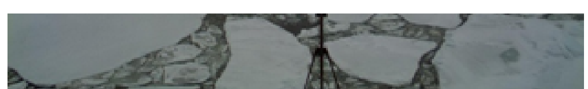
Surface dissolved Fe (<0.4 um) during spring 2007
Aguilar-Islas, Rember, and Wu unpublished data

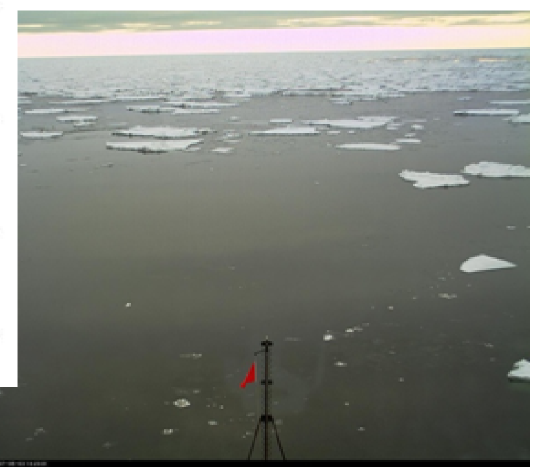
Sea ice as a source of iron

Station 1: 128 m, 0% ice cover
Station 2: 135 m, 80% ice cover
Station 3: 124 m, 50% ice cover









Aguilar-Islas et al. (2008) *GRL*

Predicted ice dynamics from numerical model

(Zhang and Rothrock, 2003, Mon. Weather Rev.)

Ice thickness =

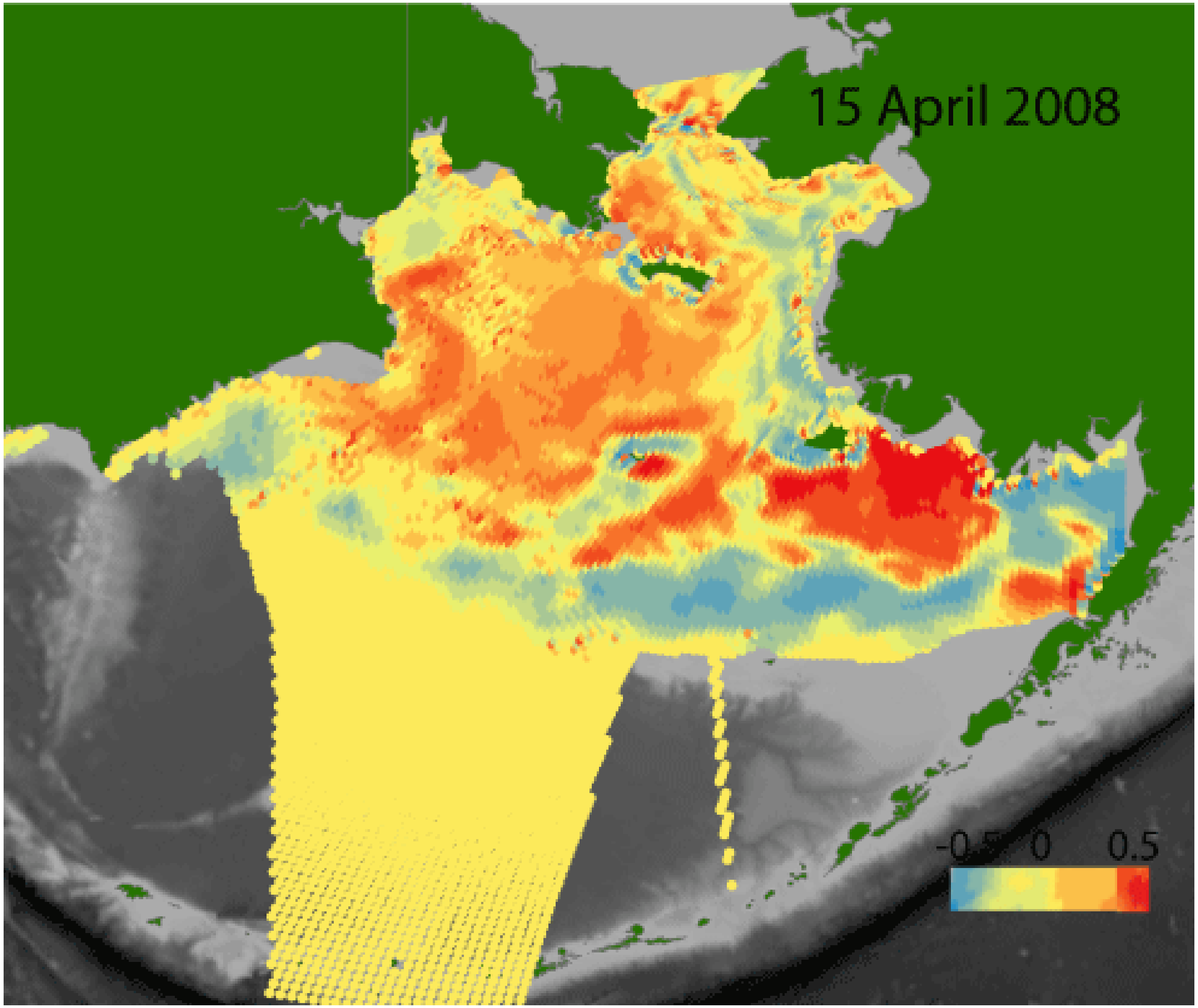
local production (freezing & melting)

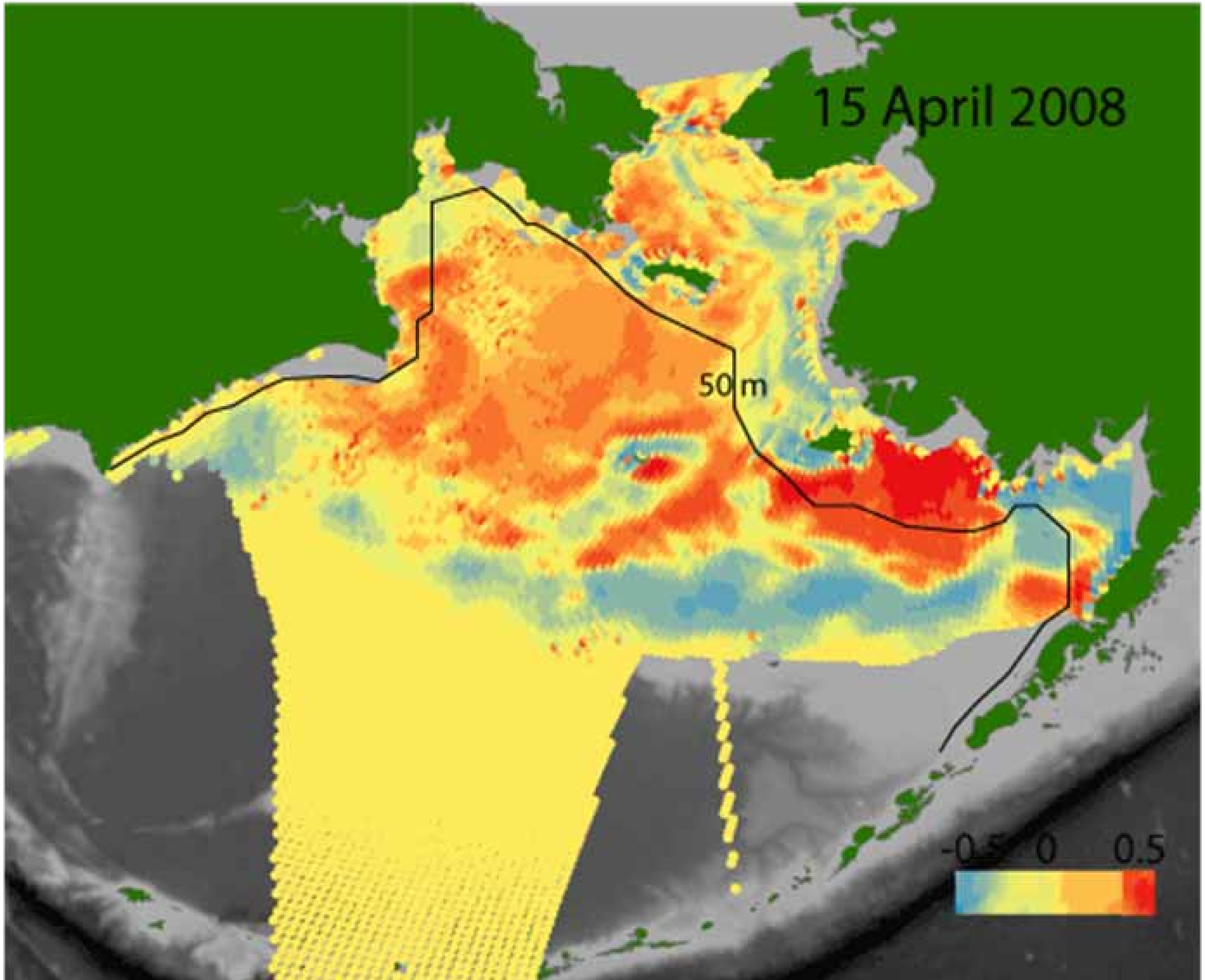
\+ drift

Zhang and Rothrock (2005), J. Geophys. Res.

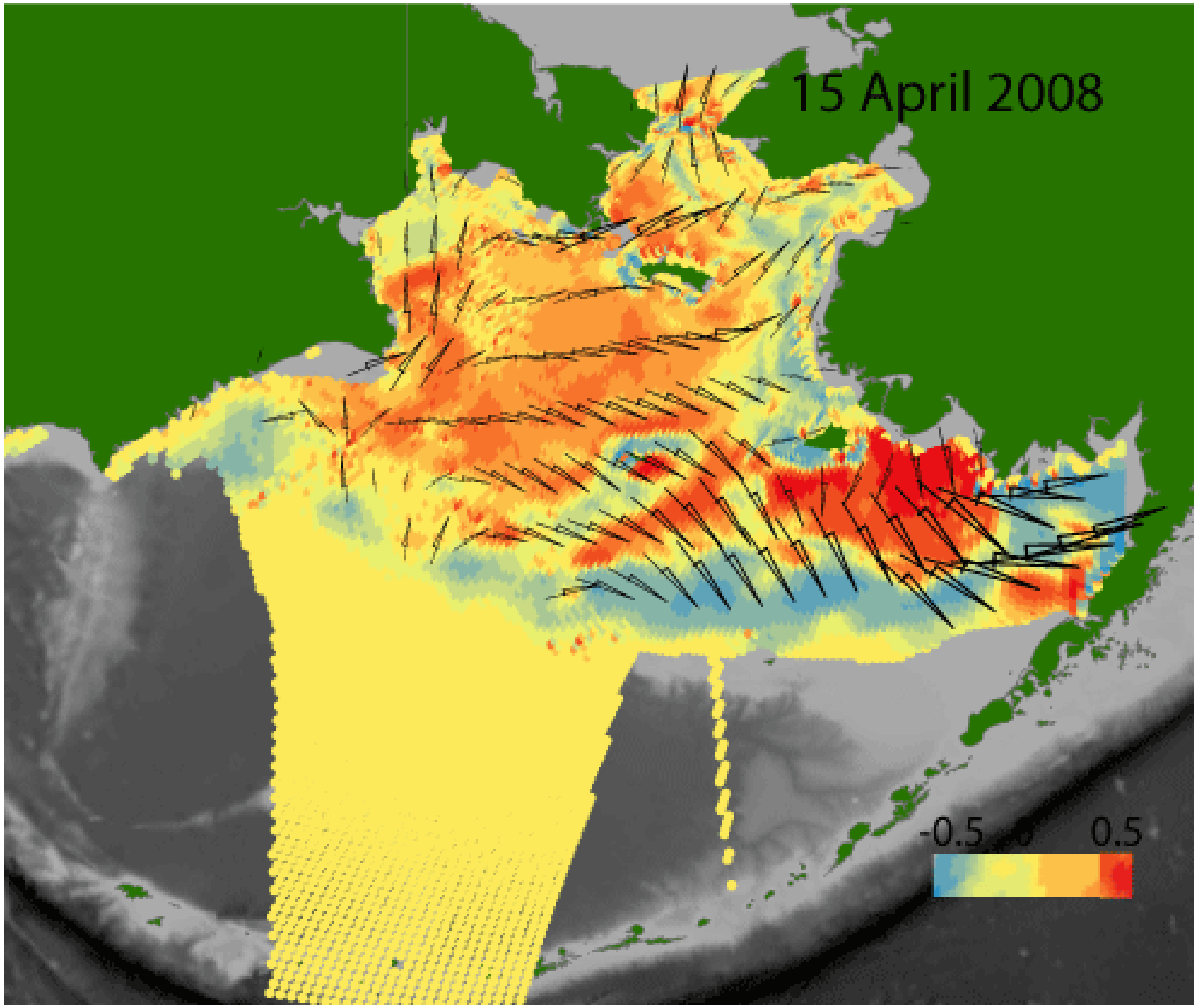
Lindsay and Zhang (2006), J. Atmos. Oceanic Technol.

Ice production (Local freezing & melting)

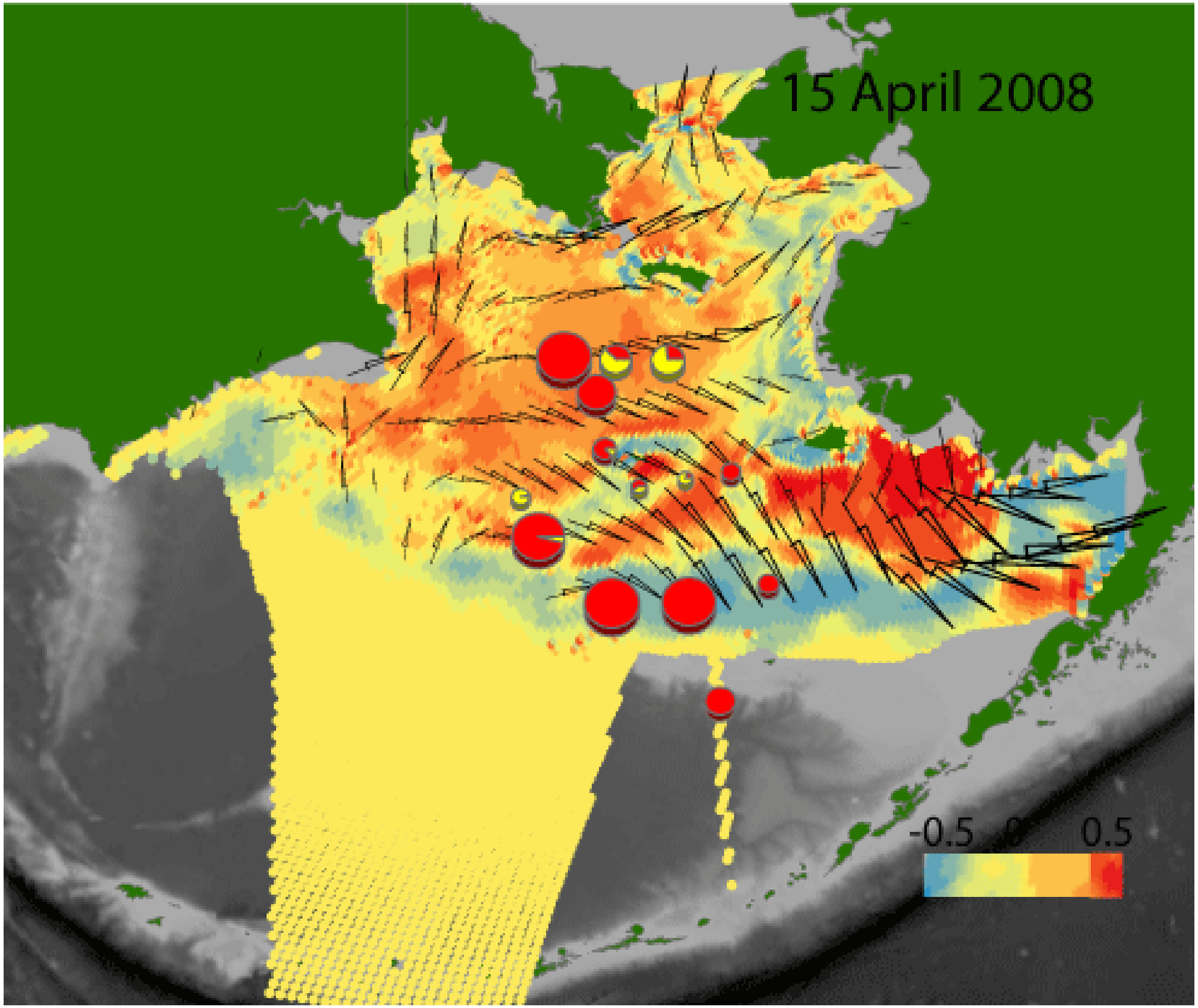



15 April 2008
50 m
-0.5
0
0.5

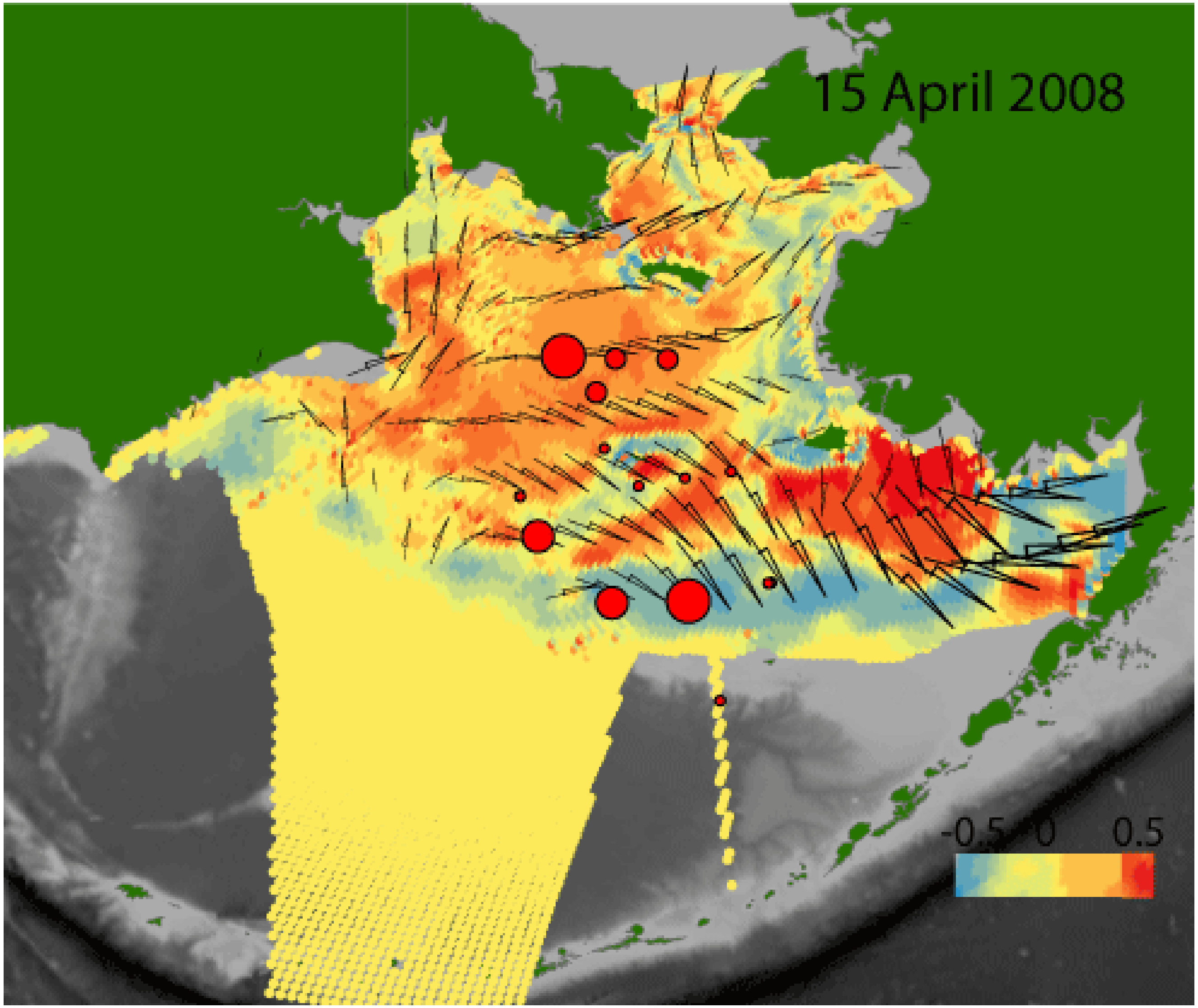
Ice production + drift

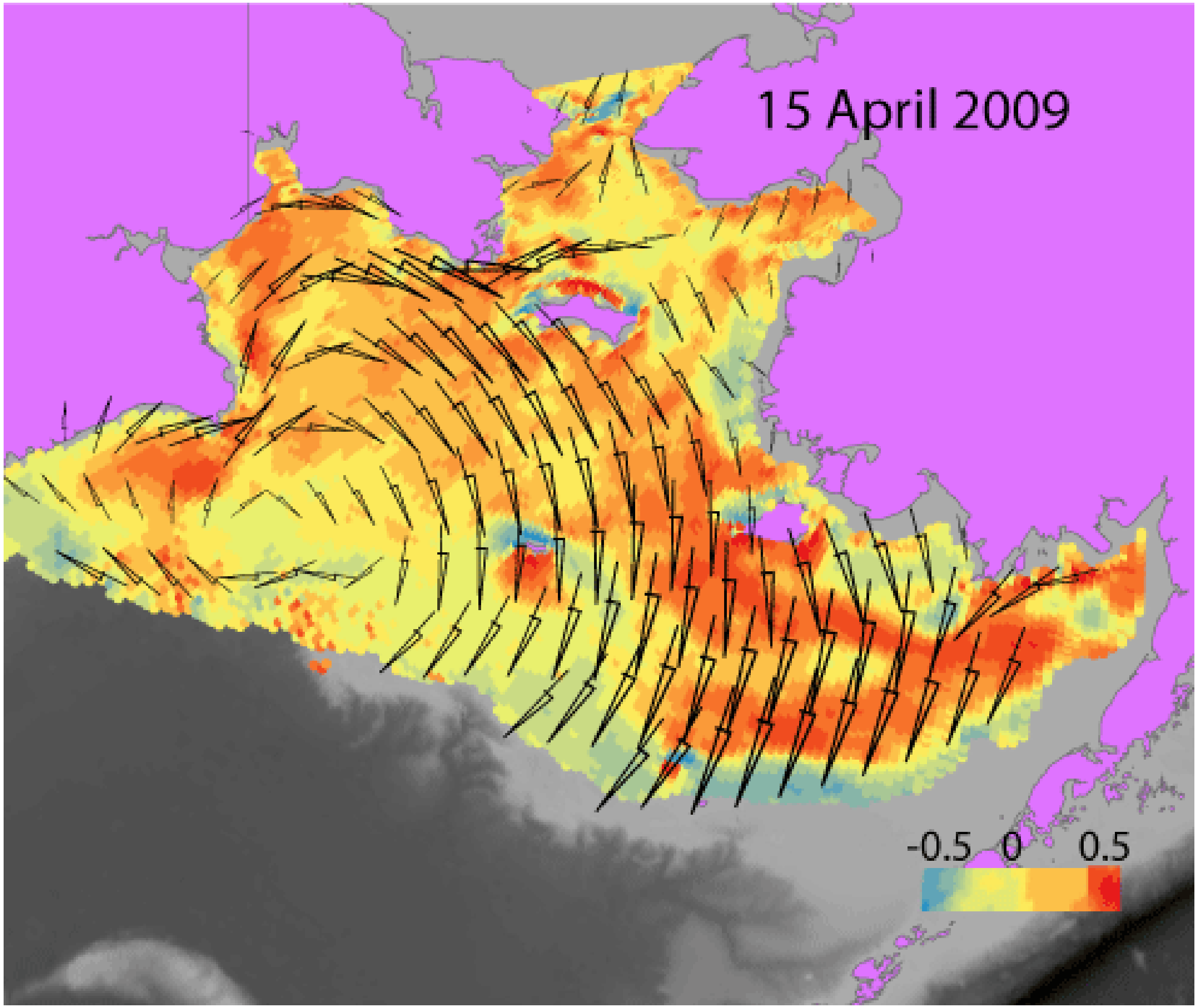


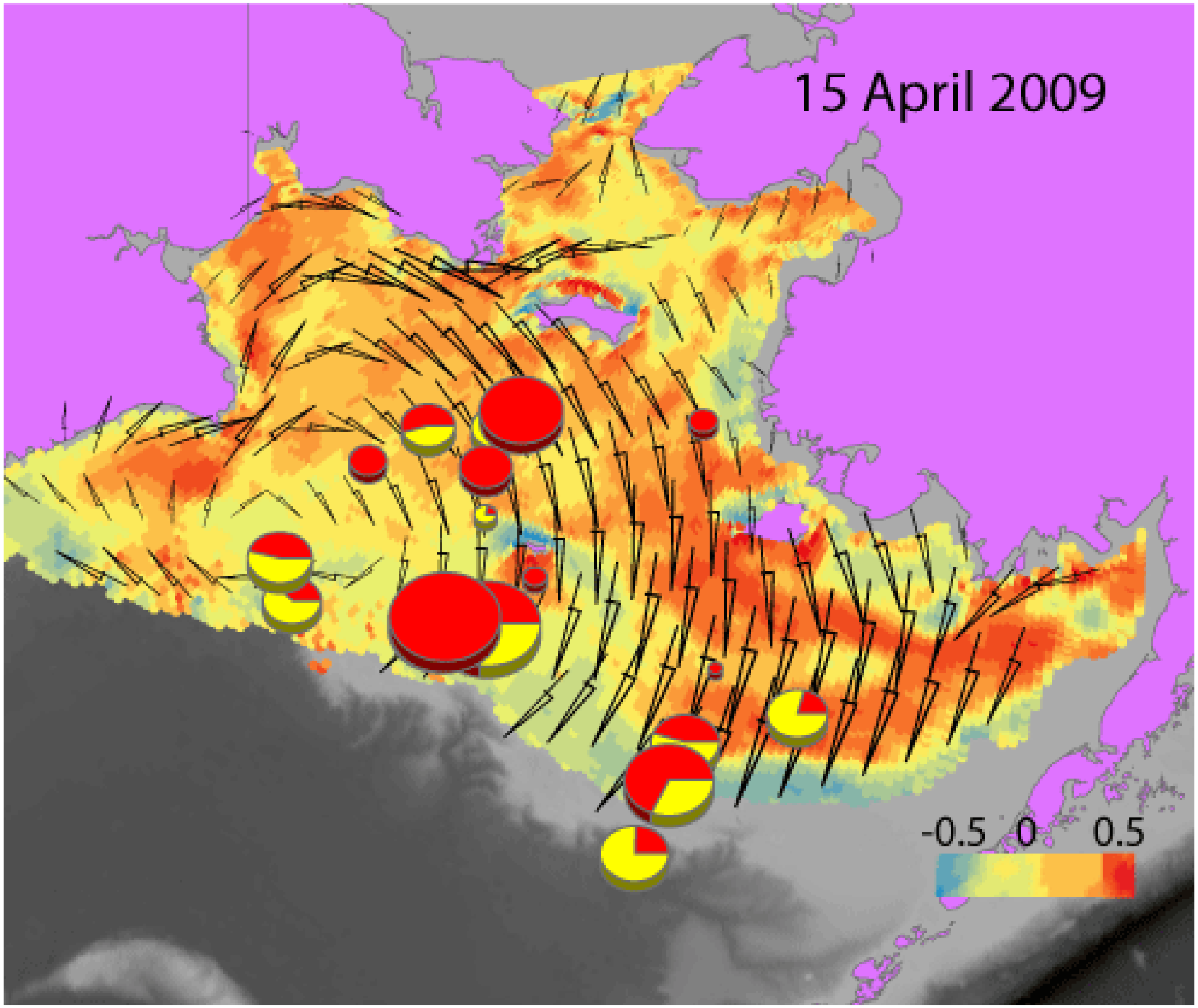
New & regenerated production

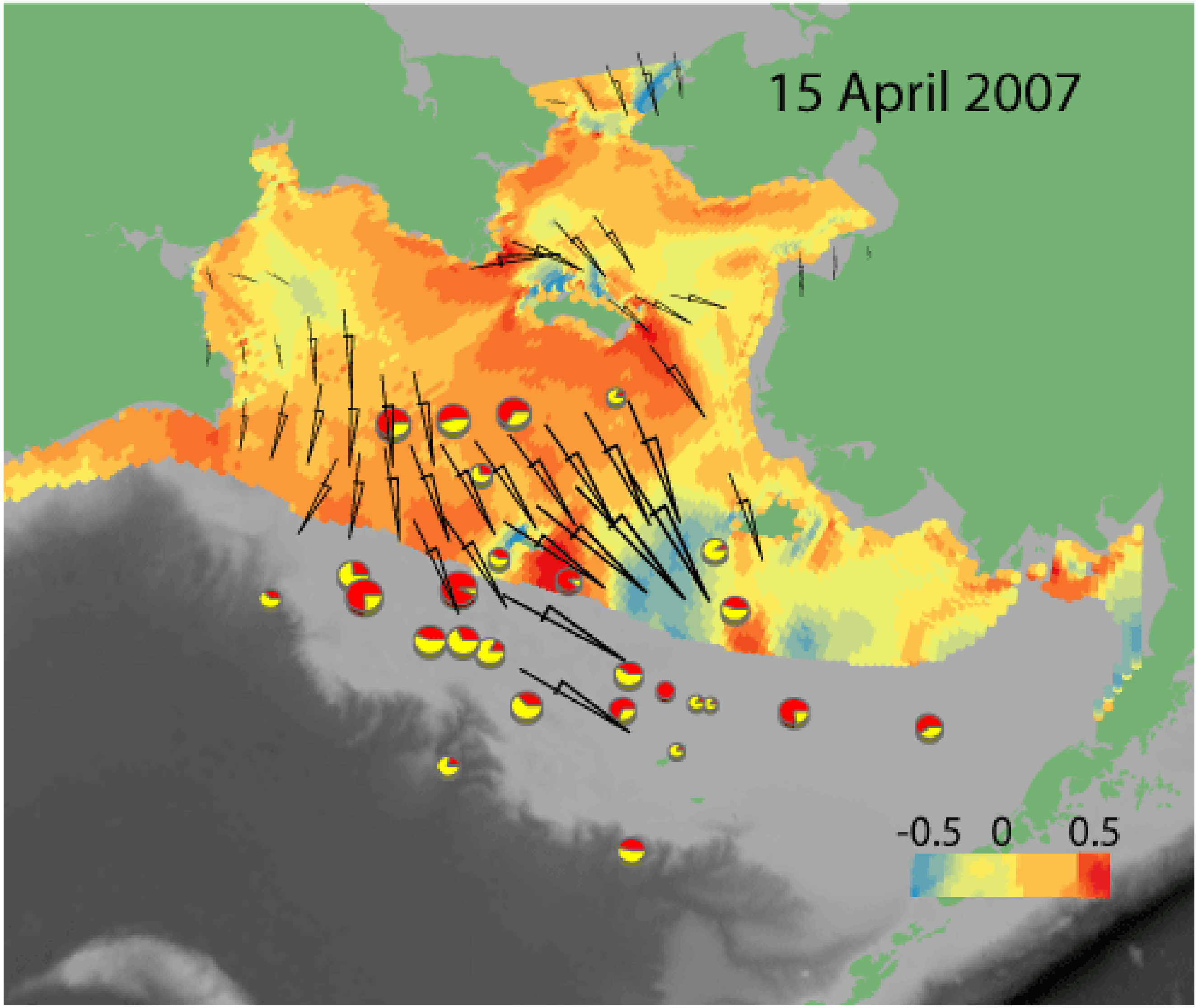


Primary (C) production

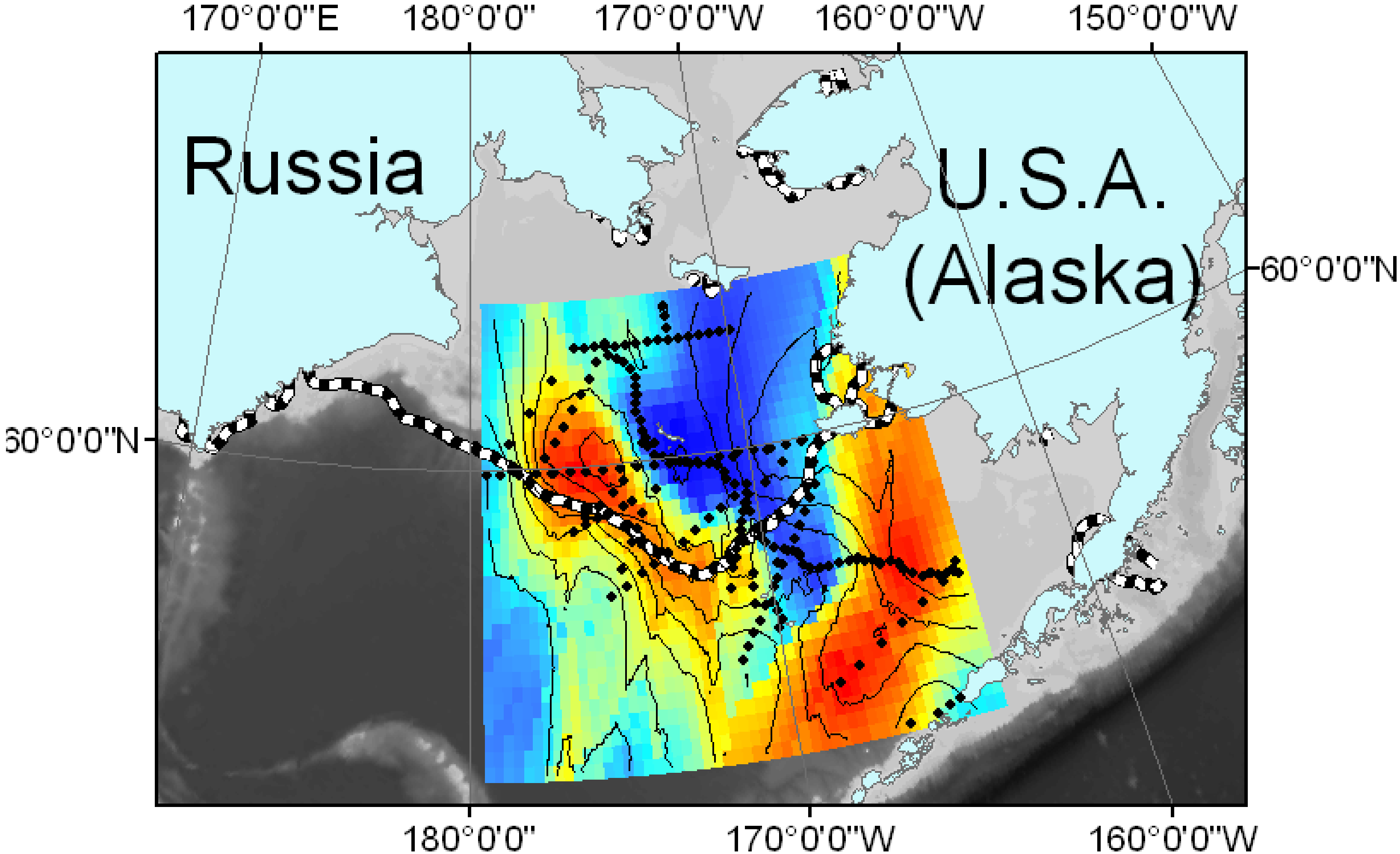


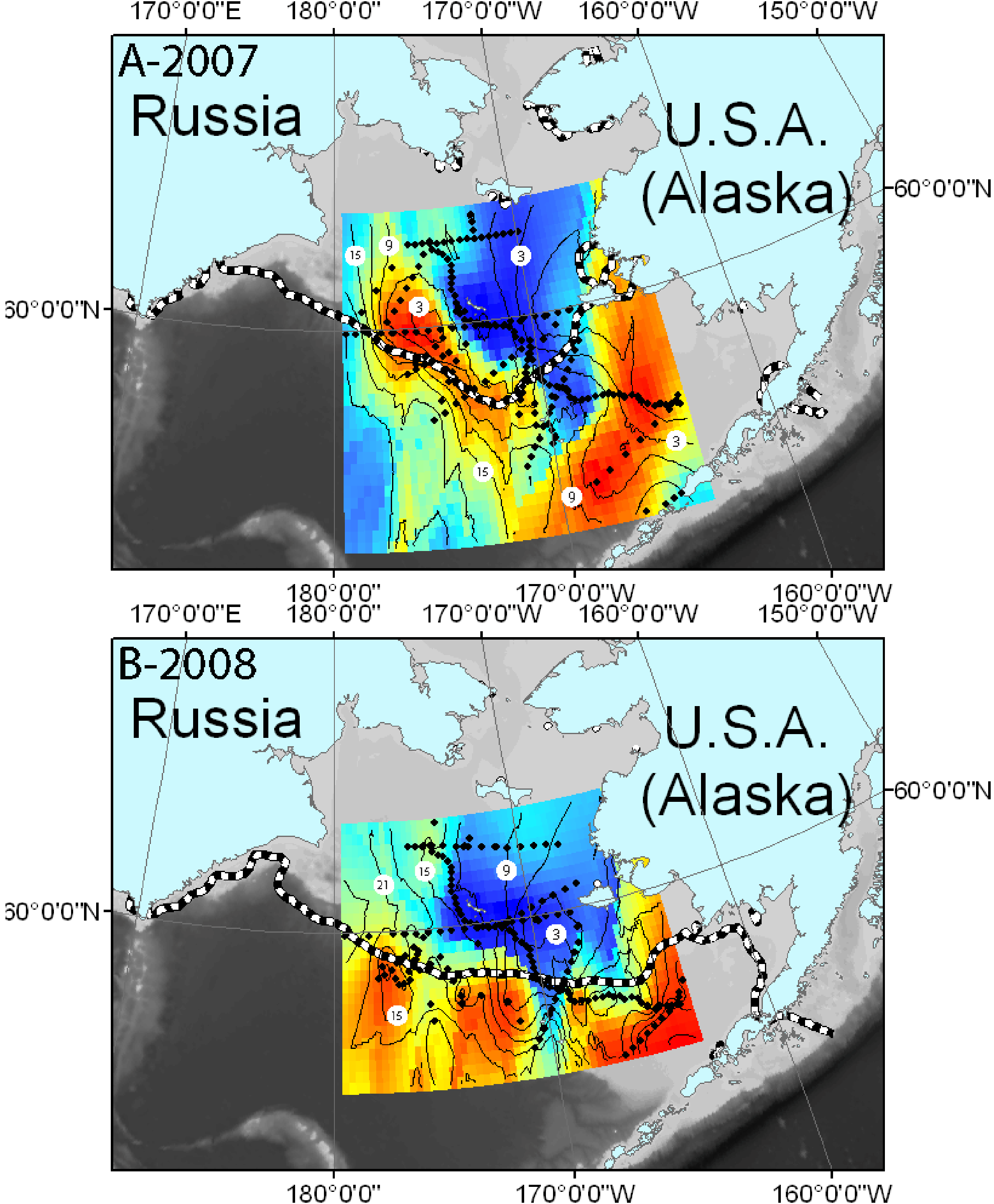

15 April 2009
-0.5 0 0.5


15 April 2009
-0.5 0 0.5

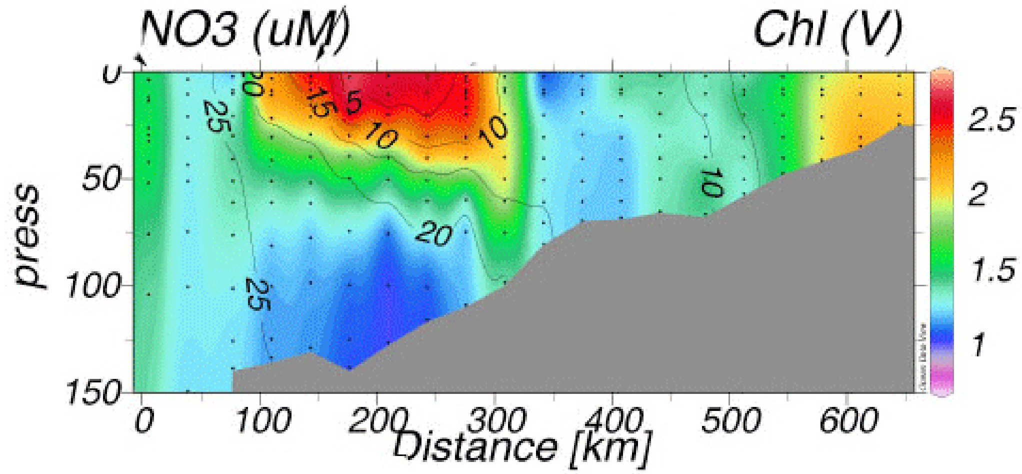

15 April 2007
-0.5 0 0.5

2007 Ship Chl a & NO_3

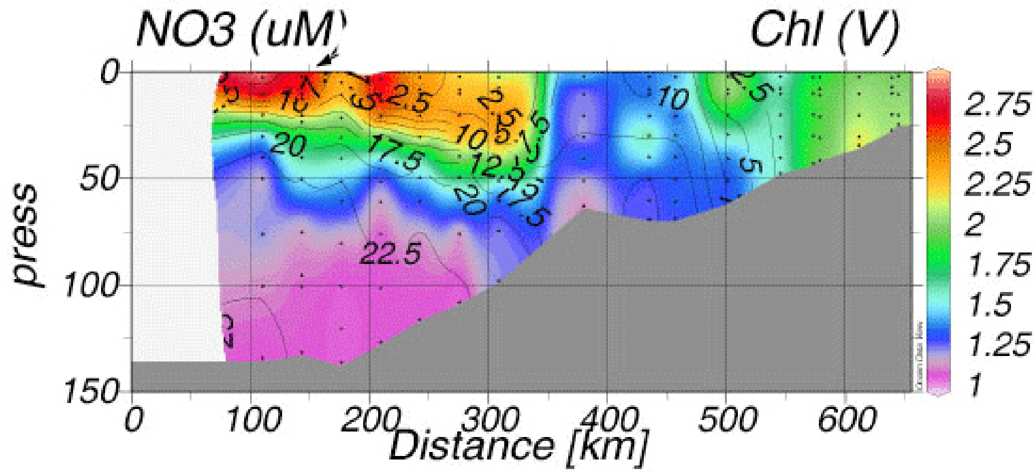



A-2007
Russia
U.S.A.
(Alaska)
170°0'0"E
180°0'0"
170°0'0"W
160°0'0"W
150°0'0"W
60°0'0"N
60°0'0"N
180°0'0"
170°0'0"W
160°0'0"W
15
9
3
3
3
15
9
B-2008
Russia
U.S.A.
(Alaska)
170°0'0"E
180°0'0"
170°0'0"W
160°0'0"W
150°0'0"W
60°0'0"N
60°0'0"N
180°0'0"
170°0'0"W
160°0'0"W
15
9
21
3
15

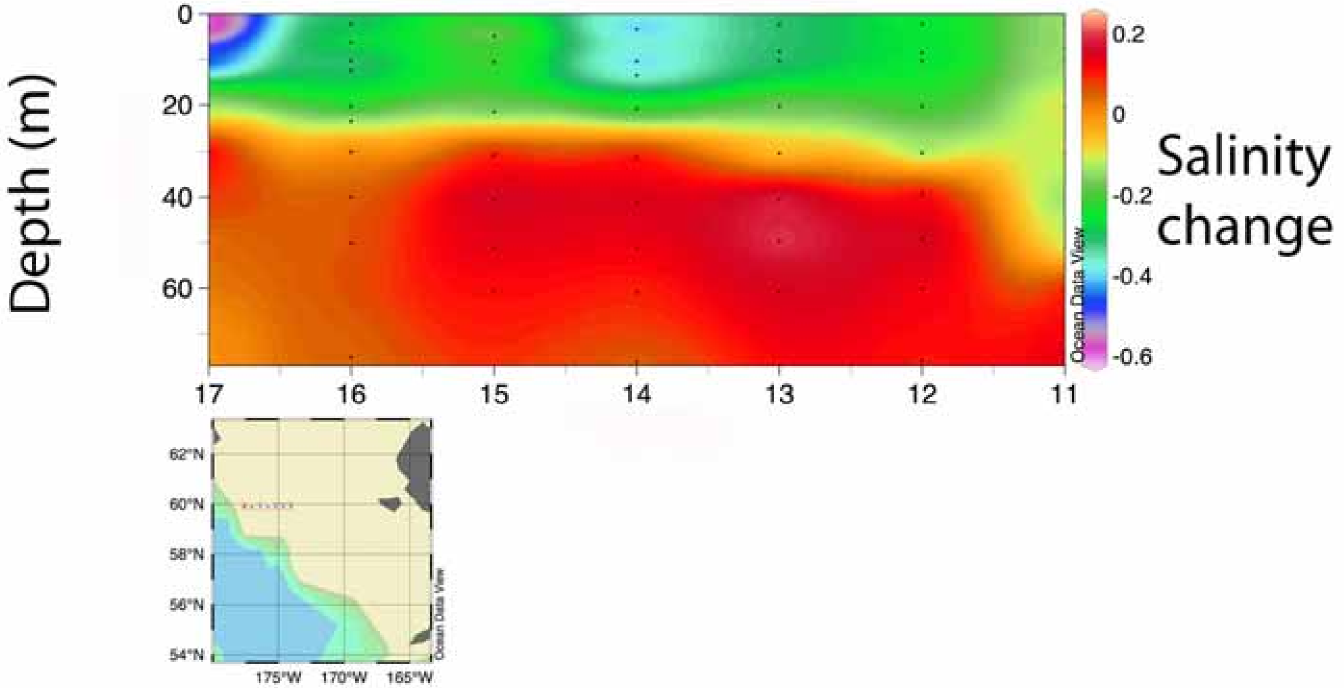
Melt pool location, 2007



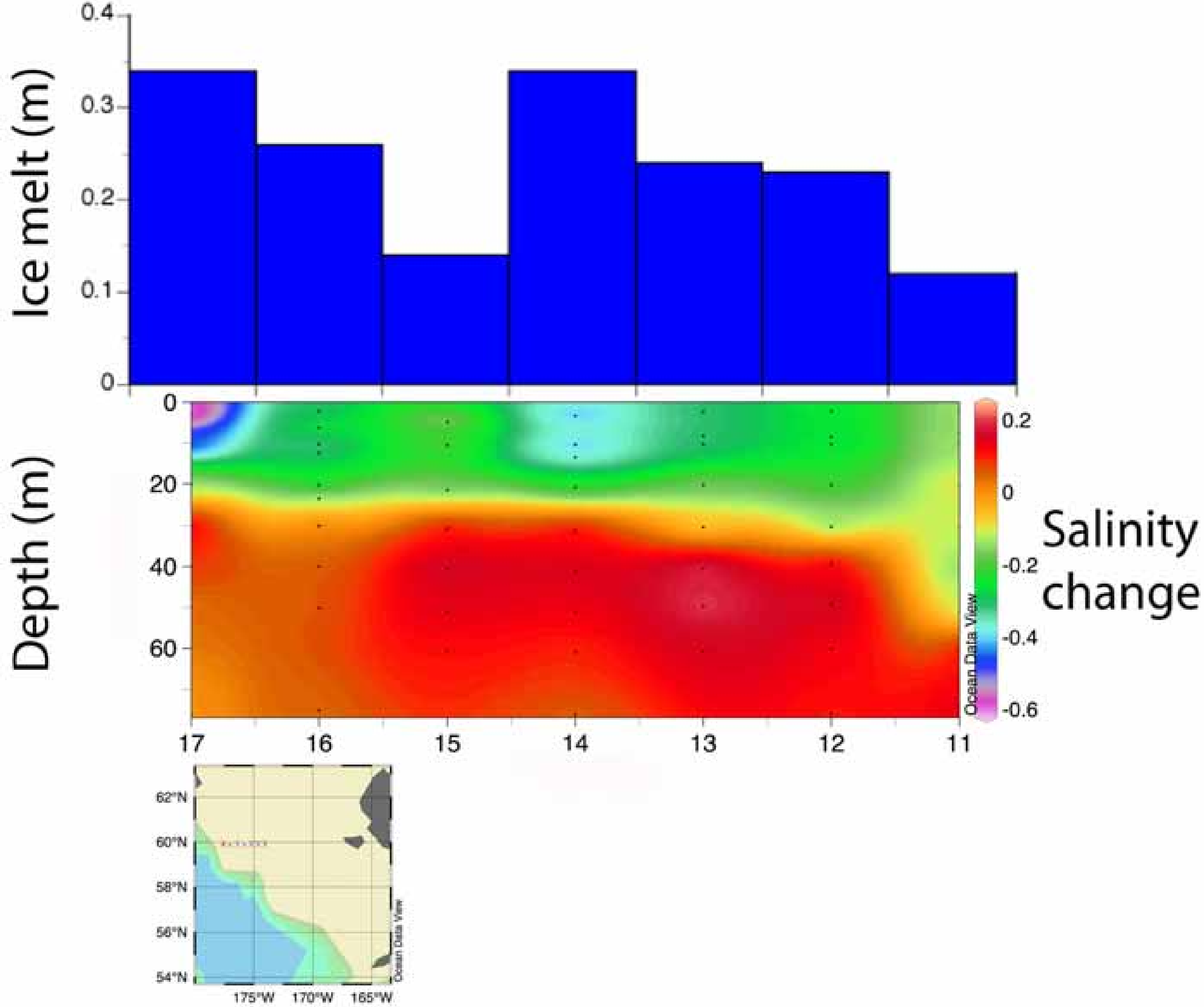
MN Section april 2007

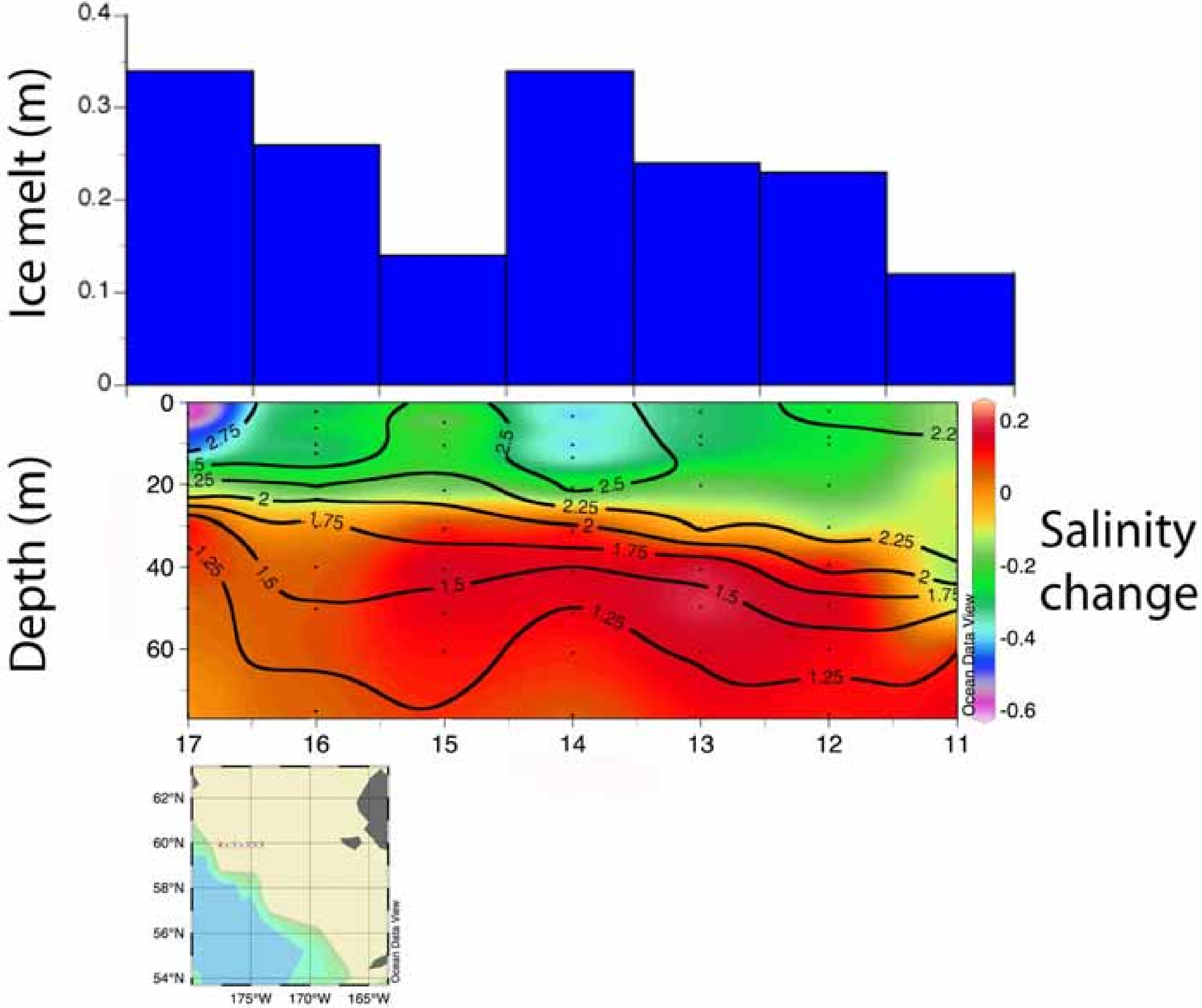


MN Section may 2007

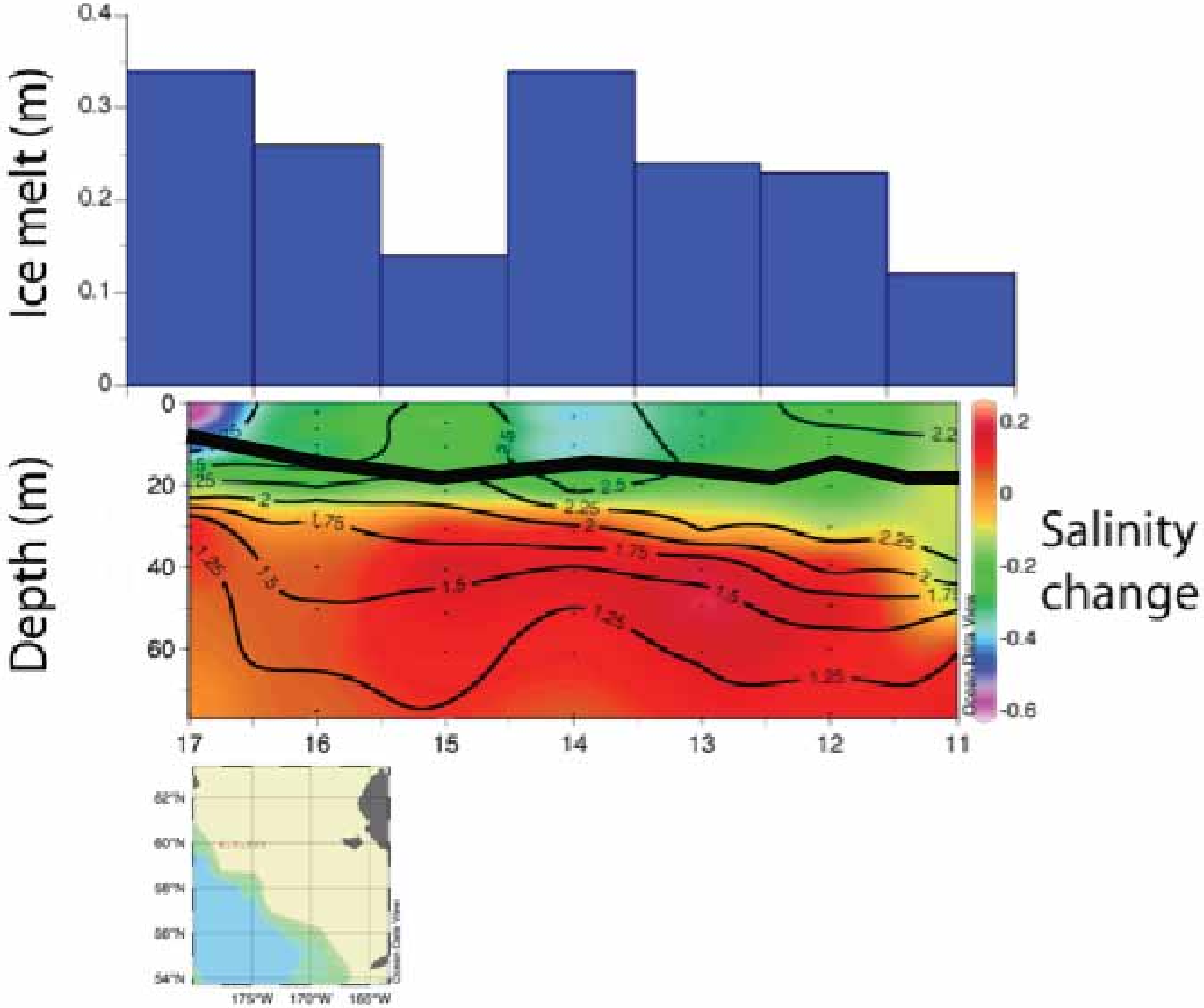


Depth (m)
0
20
40
60
17
16
15
14
13
12
11
0.2
0
-0.2
-0.4
-0.6
Ocean Data View
Salinity change
62°N
60°N
58°N
56°N
54°N
175°W
170°W
165°W
Ocean Data View


0.4
0.3
0.2
0.1
0
Ice melt (m)
0
20
40
60
Depth (m)
17
16
15
14
13
12
11
0.2
0
-0.2
-0.4
-0.6
Ocean Data View
Salinity change
62°N
60°N
58°N
56°N
54°N
175°W
170°W
165°W
Ocean Data View

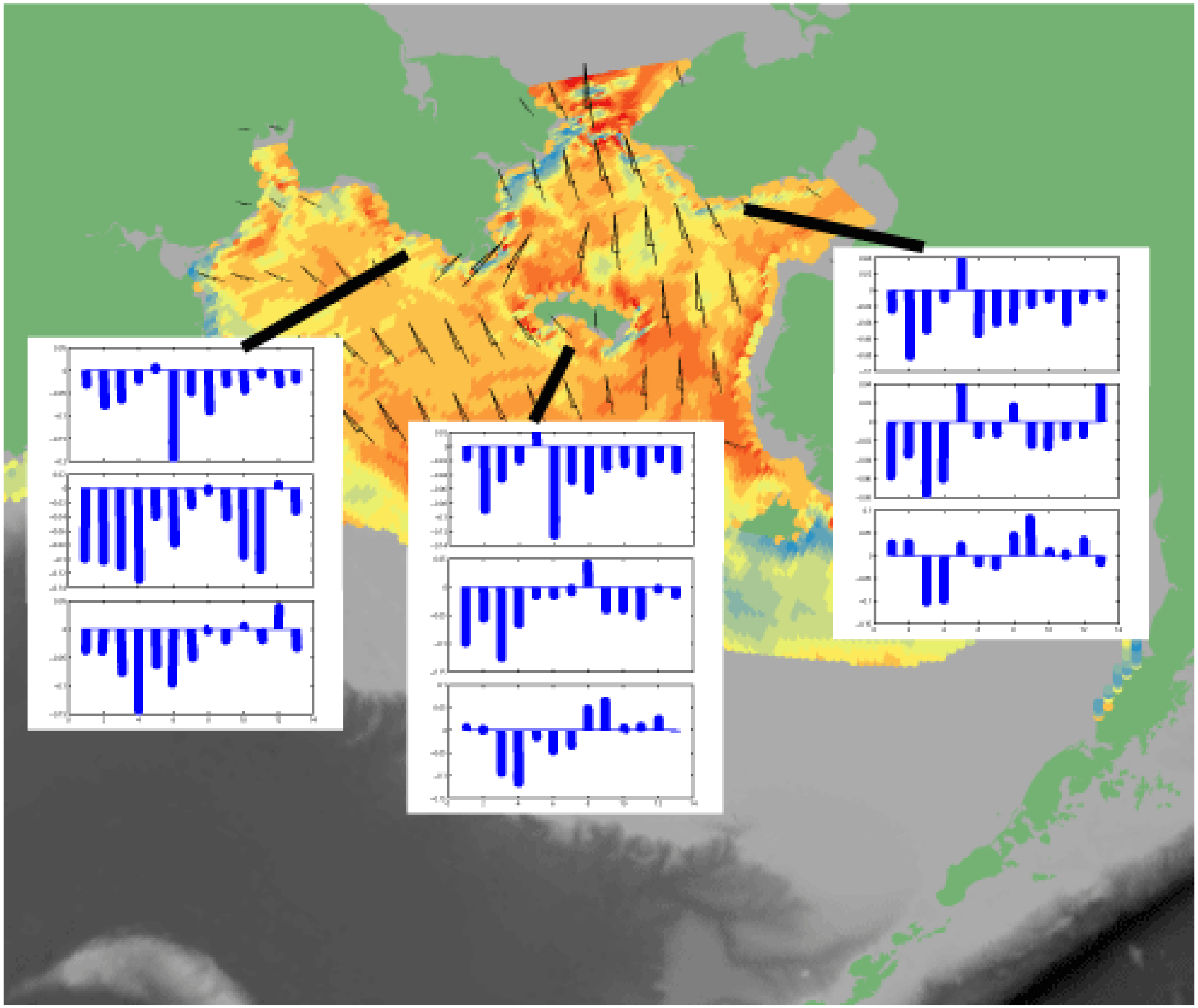


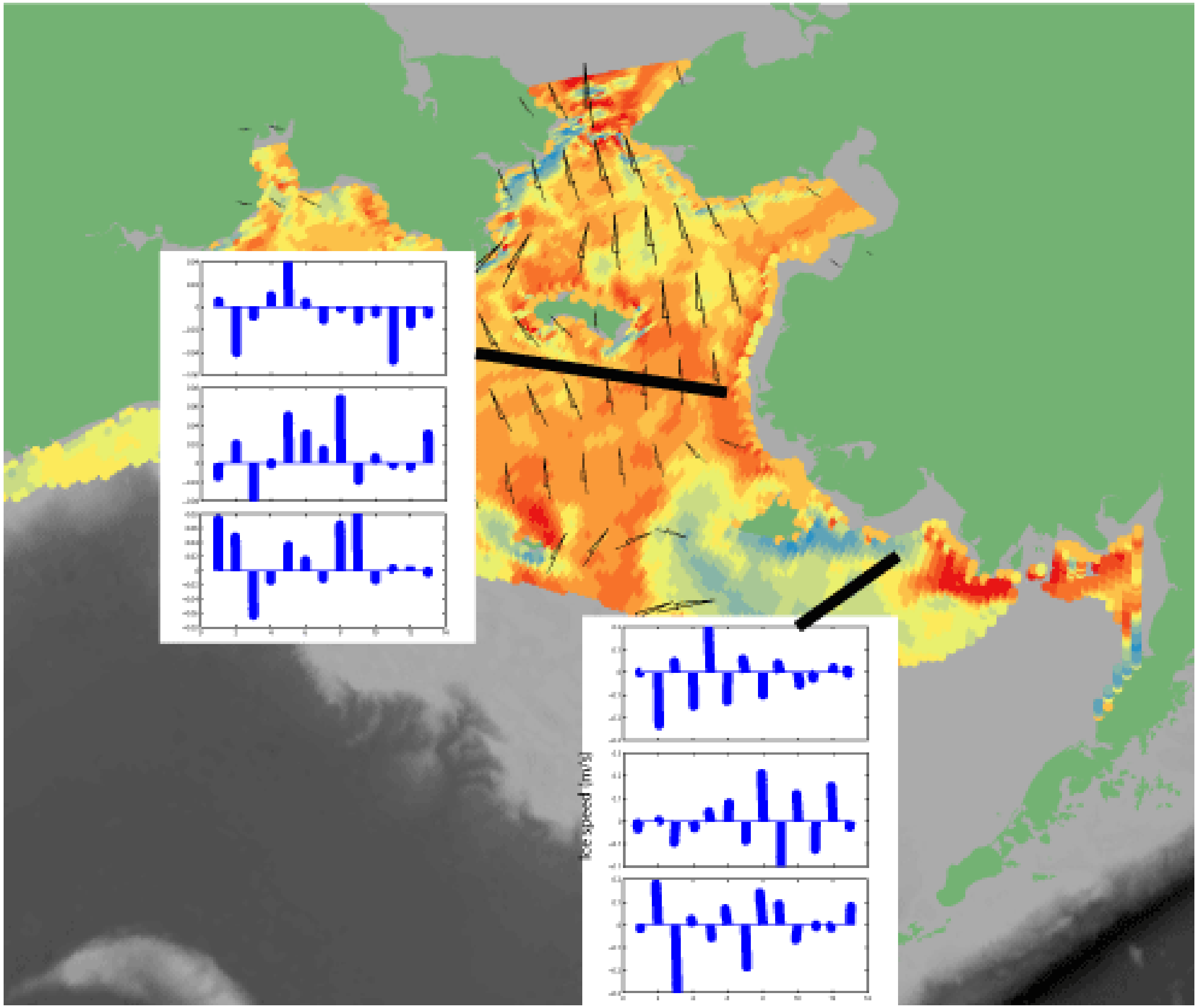
Ice melt (m)
0.4
0.3
0.2
0.1
0
Depth (m)
0
20
40
60
17
16
15
14
13
12
11
Salinity change
0.2
0
-0.2
-0.4
-0.6
Ocean Data View
62°N
60°N
58°N
56°N
54°N
175°W
170°W
165°W



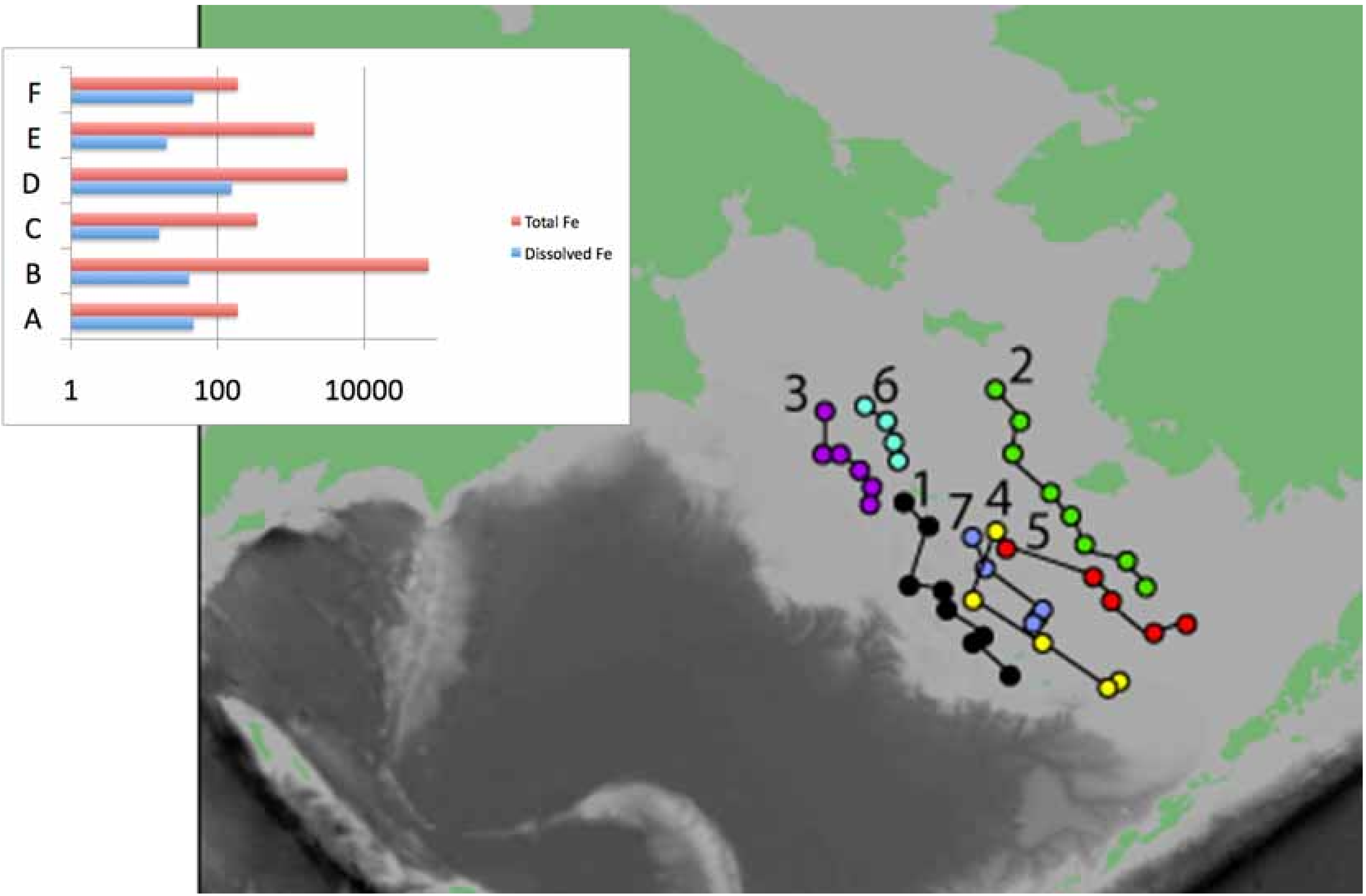
Ice melt (m)
0.4
0.3
0.2
0.1
0
Depth (m)
0
20
40
60
17
16
15
14
13
12
11
Salinity change
0.2
0
-0.2
-0.4
-0.6

Time series of ice movement in coastal regions




Ice speed (m/s)

Estimated ice core trajectories



Summary & Conclusions

- April productivity in the eastern Bering is dominated by the distribution and melting of ice.
- Recent ice-melt and/ or ice-melt sustained by continuous ice advection was associated with the greatest biological productivity.
- April ice dynamics control the location and timing of much of the organic deposition to the benthic community.
- Near shallow water ice generation regions, the impact of altered climate conditions on the dispersion of iron-bearing sea ice will be an important factor.