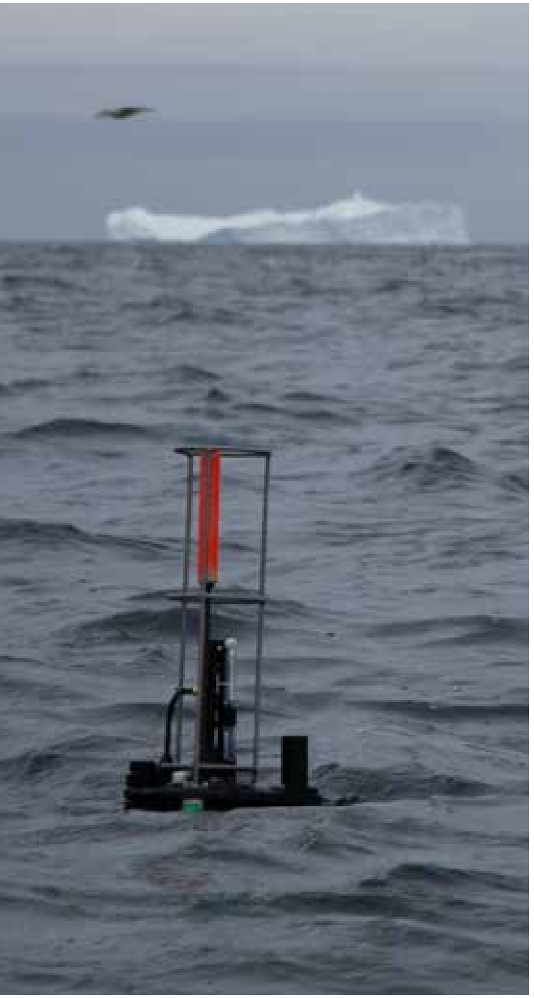
Phytoplankton phenology: Shedding light on the dark period



Marcel Babin, Achim Randelhoff

with C Marec, E Leymarie, J Lagunas, C Penkerc'h, X Xing, L Lacour, F D'Ortenzio, H Claustre, G Darnis, L Fortier, M Sampei, and the Takuvik/LOV teams

17 September 2020

NAOS Novel Argo Ocean observing System

INNOVATION.CA CANADA FOUNDATION FOR INNOVATION | FONDATION CANADIENNE POUR L'INNOVATION

cnrs dépasser les frontières

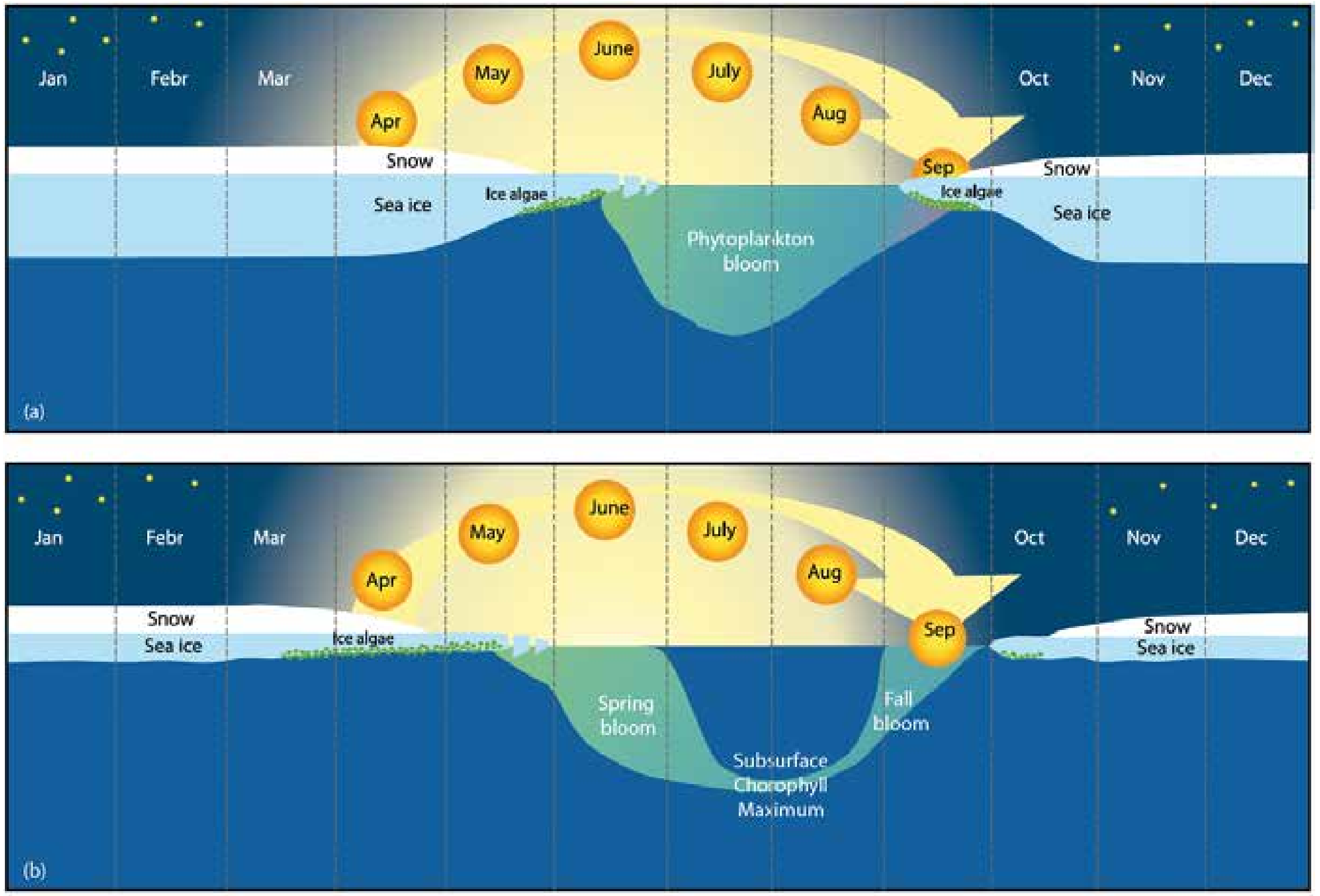
TAKUVIK

LOV

UNIVERSITÉ LAVAL

SORBONNE UNIVERSITÉ

Scientific motivations

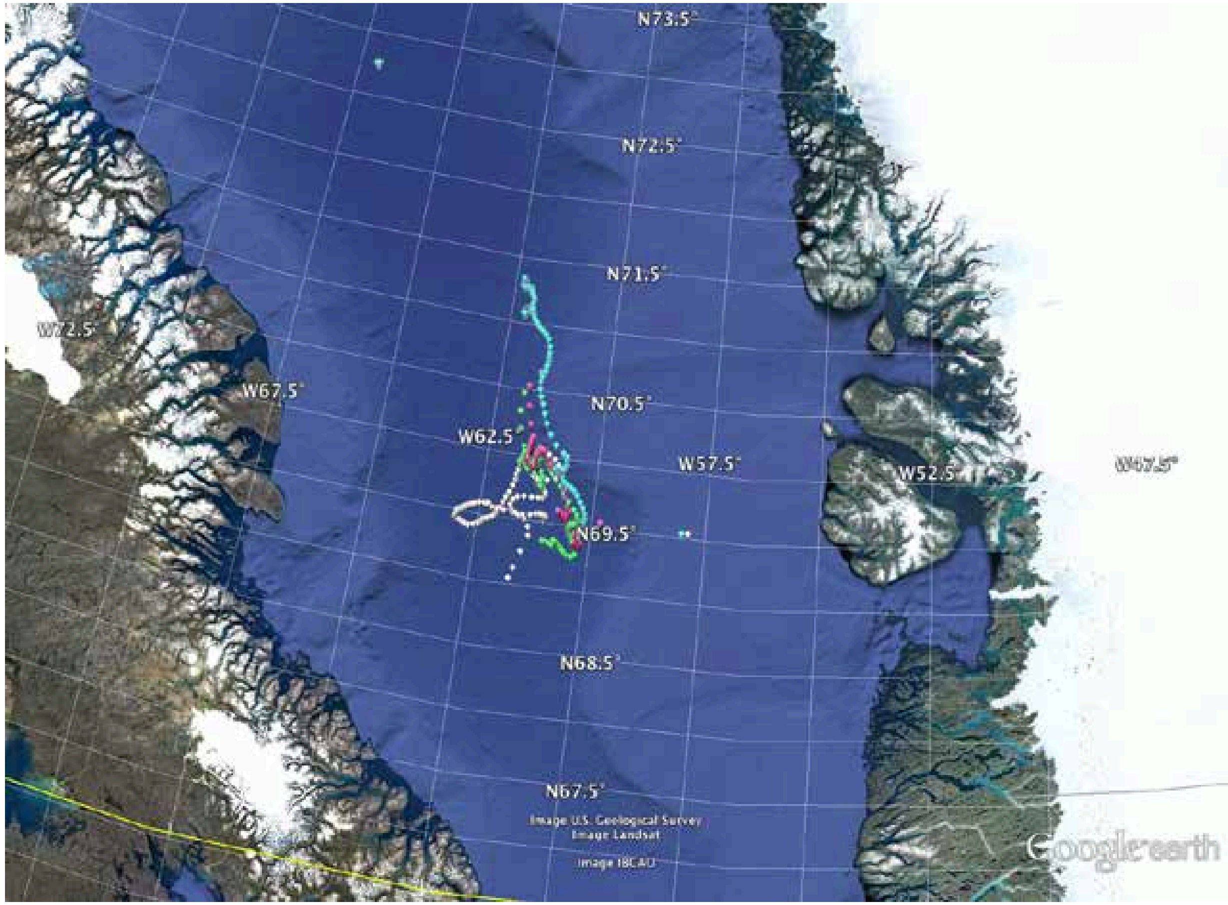


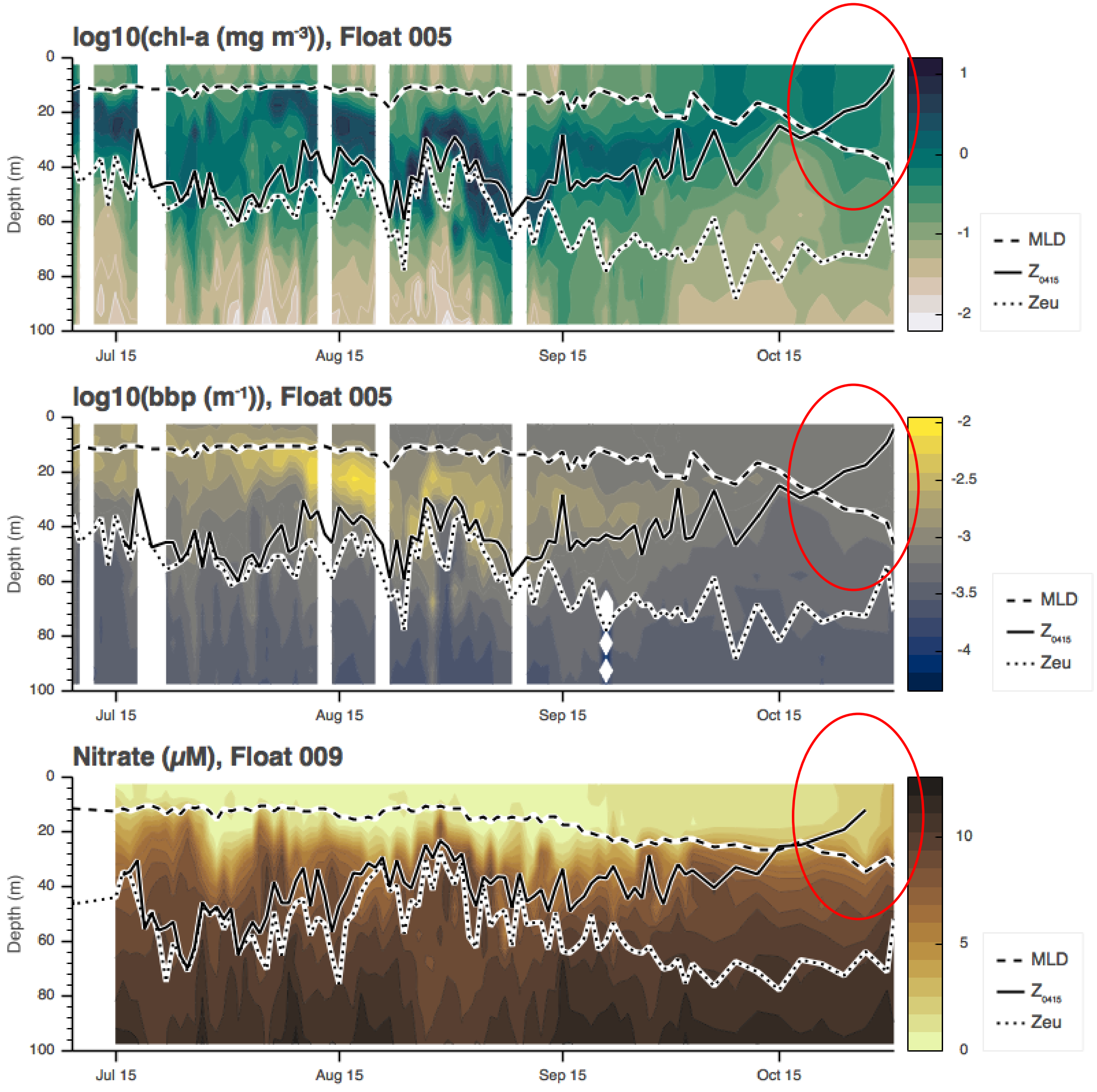
I. Entering winter (Babin et al.)

II. Going through it (Randelhoff et al.)

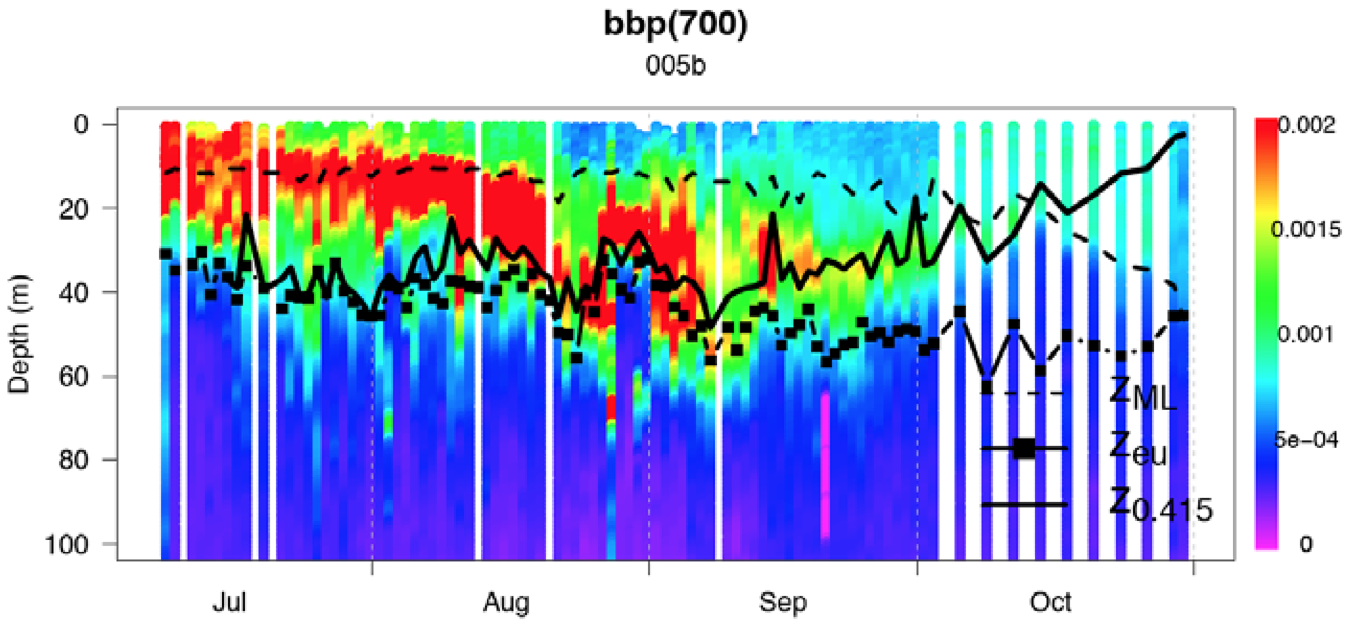
I. Entering winter

Deployment during summer 2016

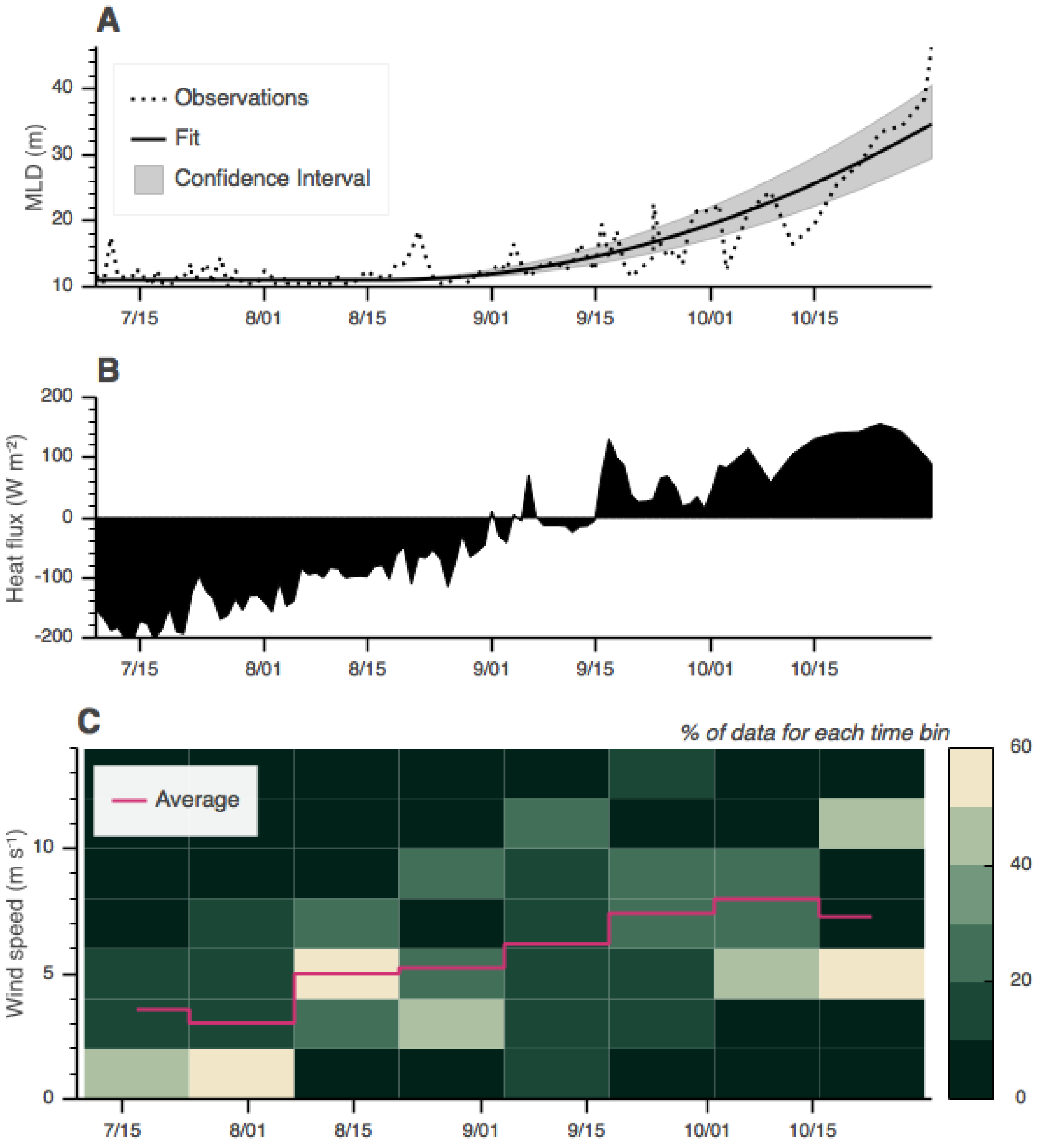




Babin et al., in prep.

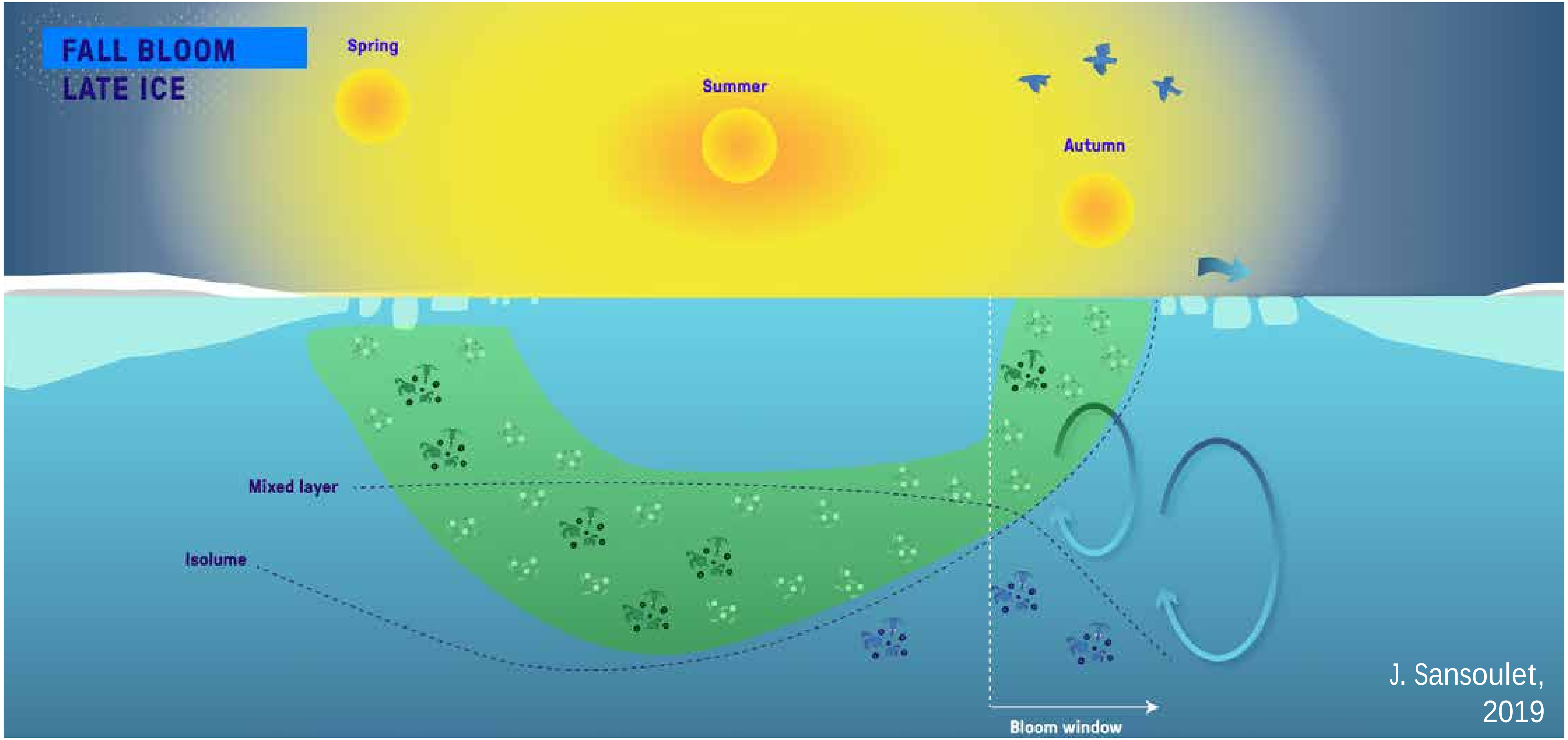


bbp(700)
005b
Depth (m)
0
20
40
60
80
100
Jul
Aug
Sep
Oct
0.002
0.0015
0.001
5e−04
0
z_{ML}
z_{eu}
$z_{0.415}$



A
Observations
Fit
Confidence Interval
MLD (m)
10
20
30
40
7/15
8/01
8/15
9/01
9/15
10/01
10/15
B
Heat flux (W m-2)
200
100
0
-100
-200
7/15
8/01
8/15
9/01
9/15
10/01
10/15
C
% of data for each time bin
Average
Wind speed (m s-1)
0
5
10
60
40
20
0
7/15
8/01
8/15
9/01
9/15
10/01
10/15

Fall bloom window in future Arctic



J. Sansoulet, 2019

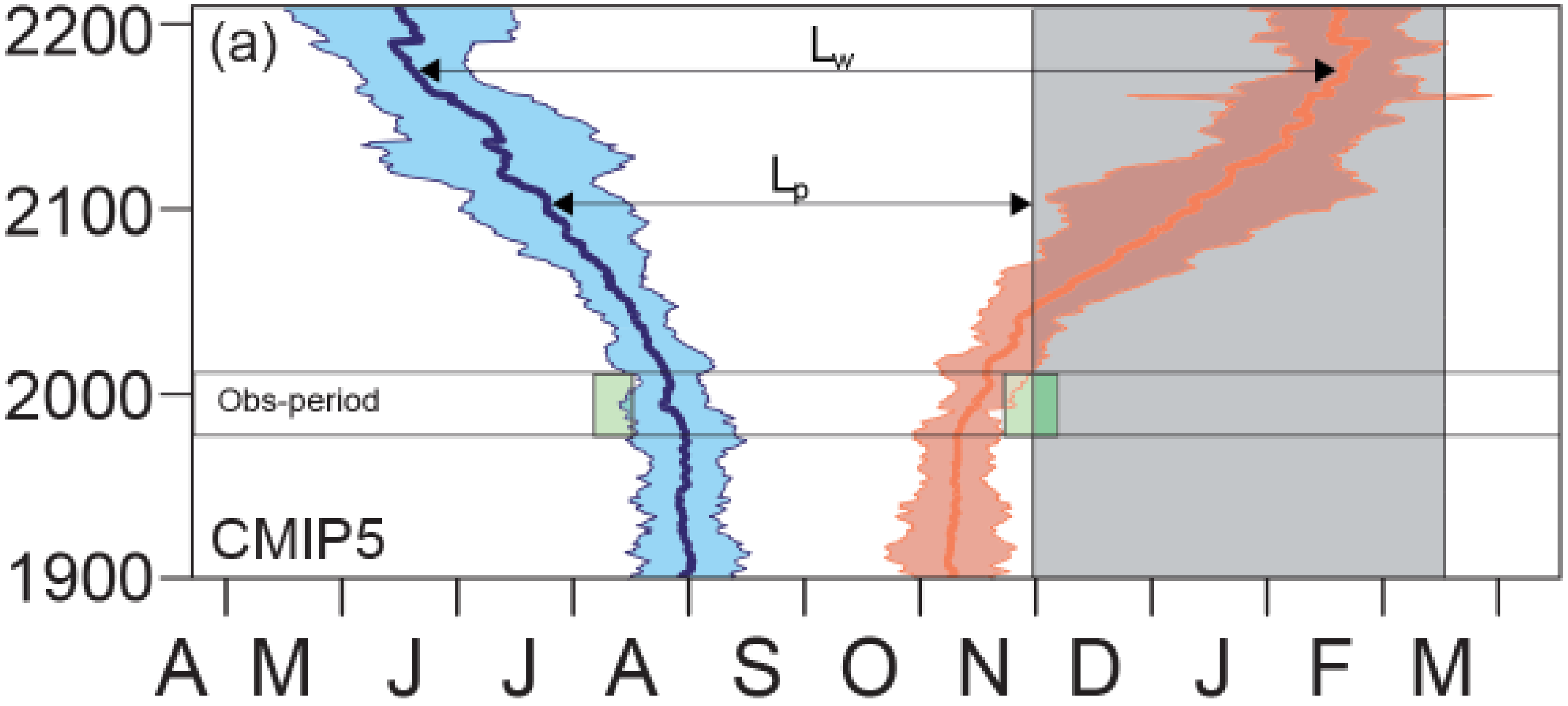
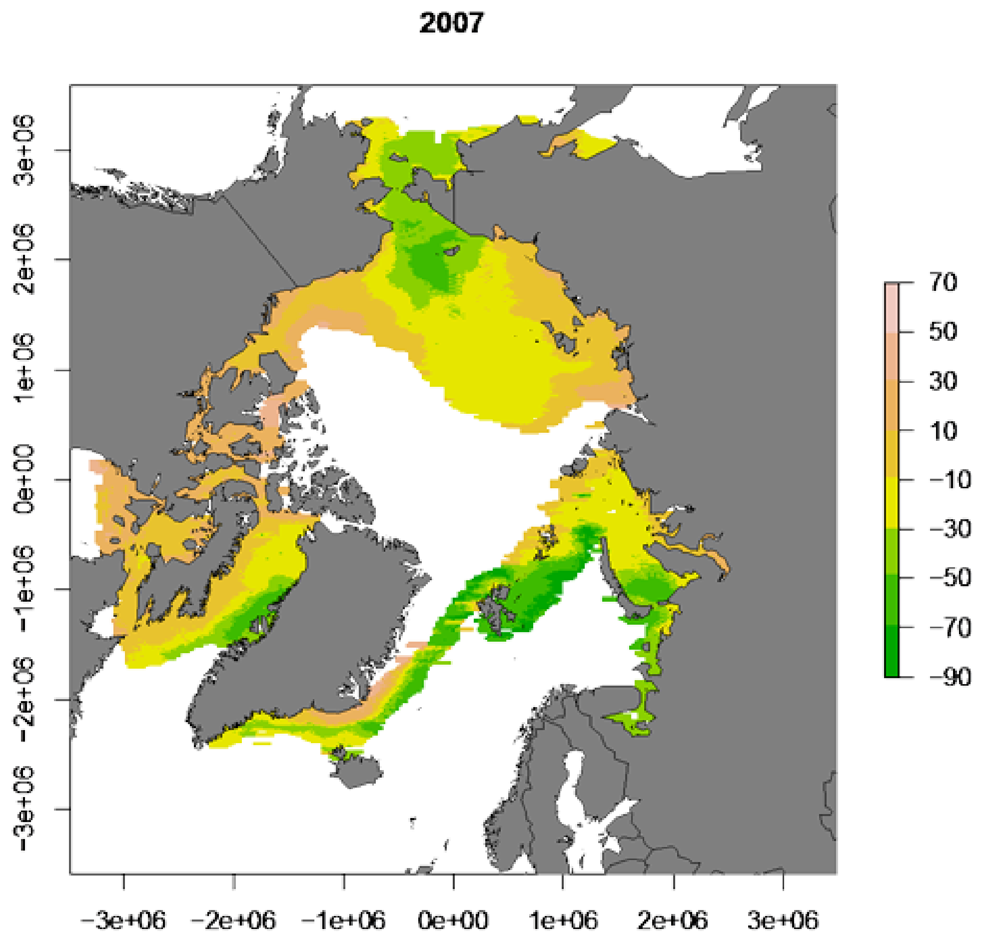


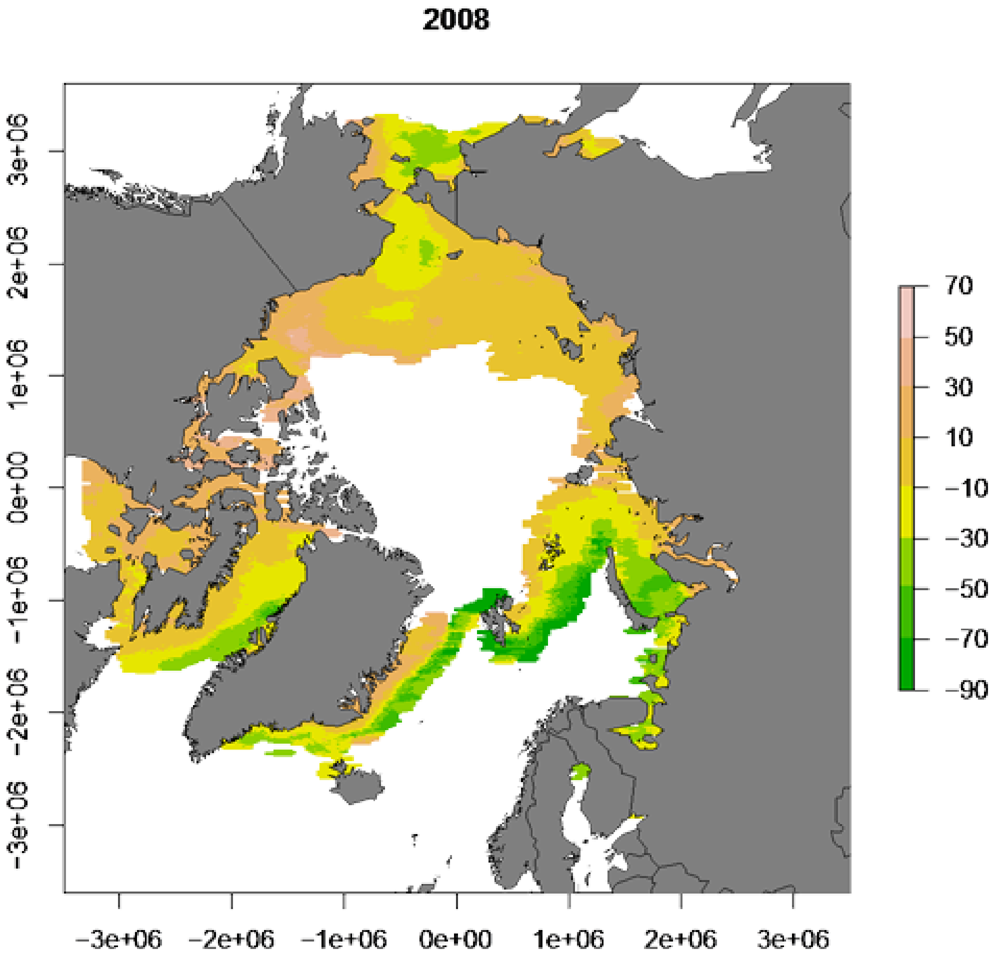
Figure 1. Evolution of the ice seasonality diagnostics (ice retreat date, blue; ice advance date, orange): **(a)** CMIP5 median and interquartile range, with corresponding range of satellite-derived values (green rectangles 1980–2015) over the 70–80° N latitude band;

Lebrun et al. (2019)

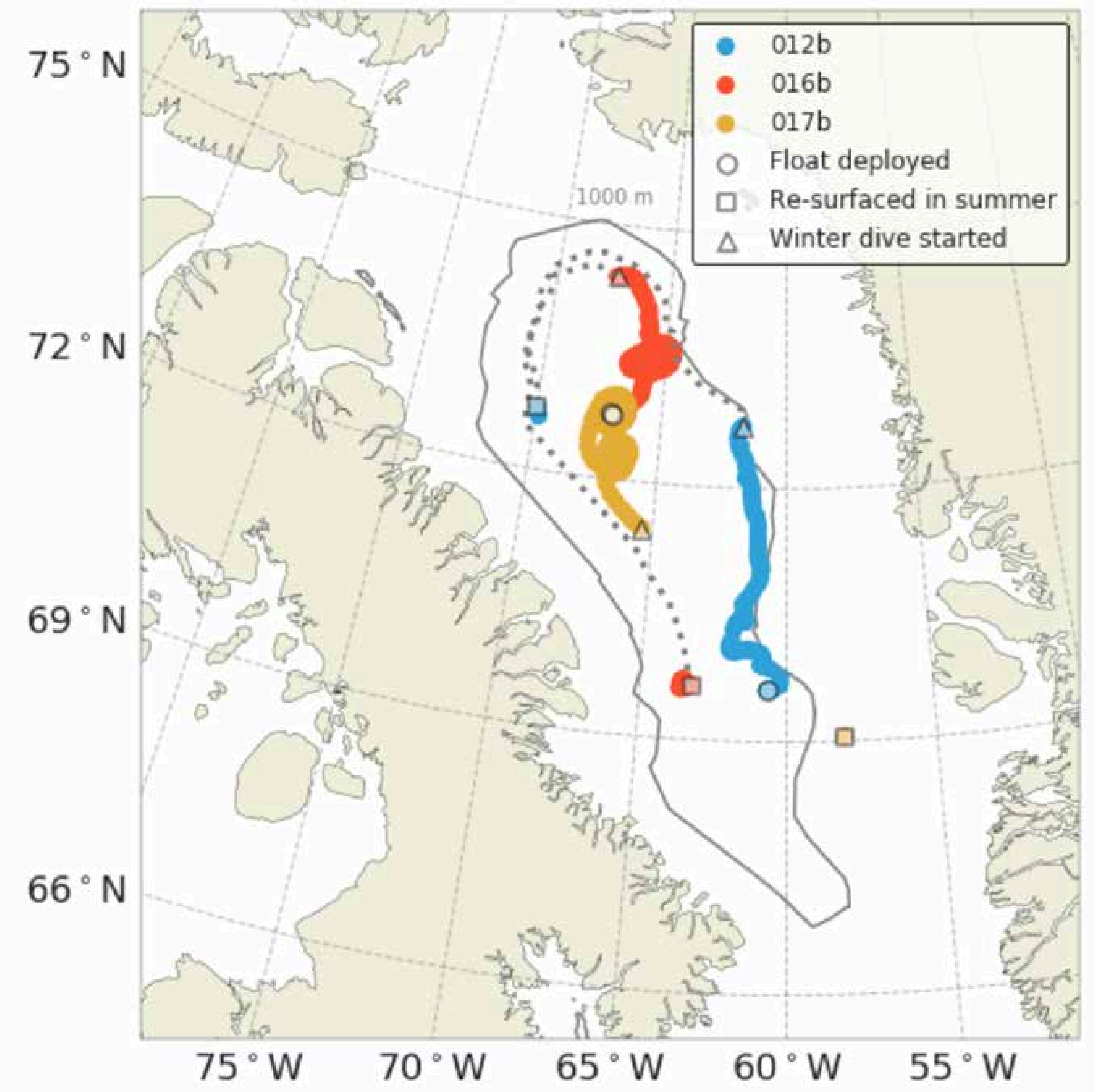
RCP8.5

Day when $Z_{0.415}$ reaches surface – day of freeze-up

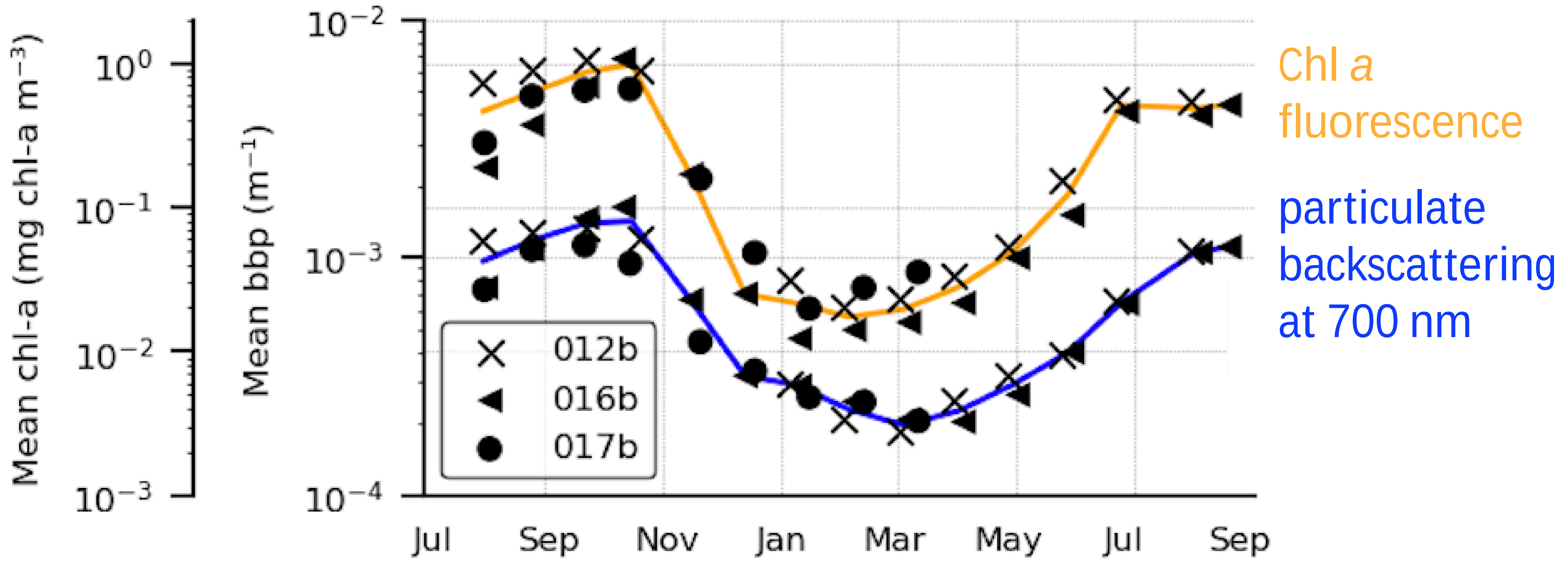




II- Going through winter



012b
016b
017b
Float deployed
Re-surfaced in summer
Winter dive started
1000 m
75 ° N
72 ° N
69 ° N
66 ° N
75 ° W
70 ° W
65 ° W
60 ° W
55 ° W



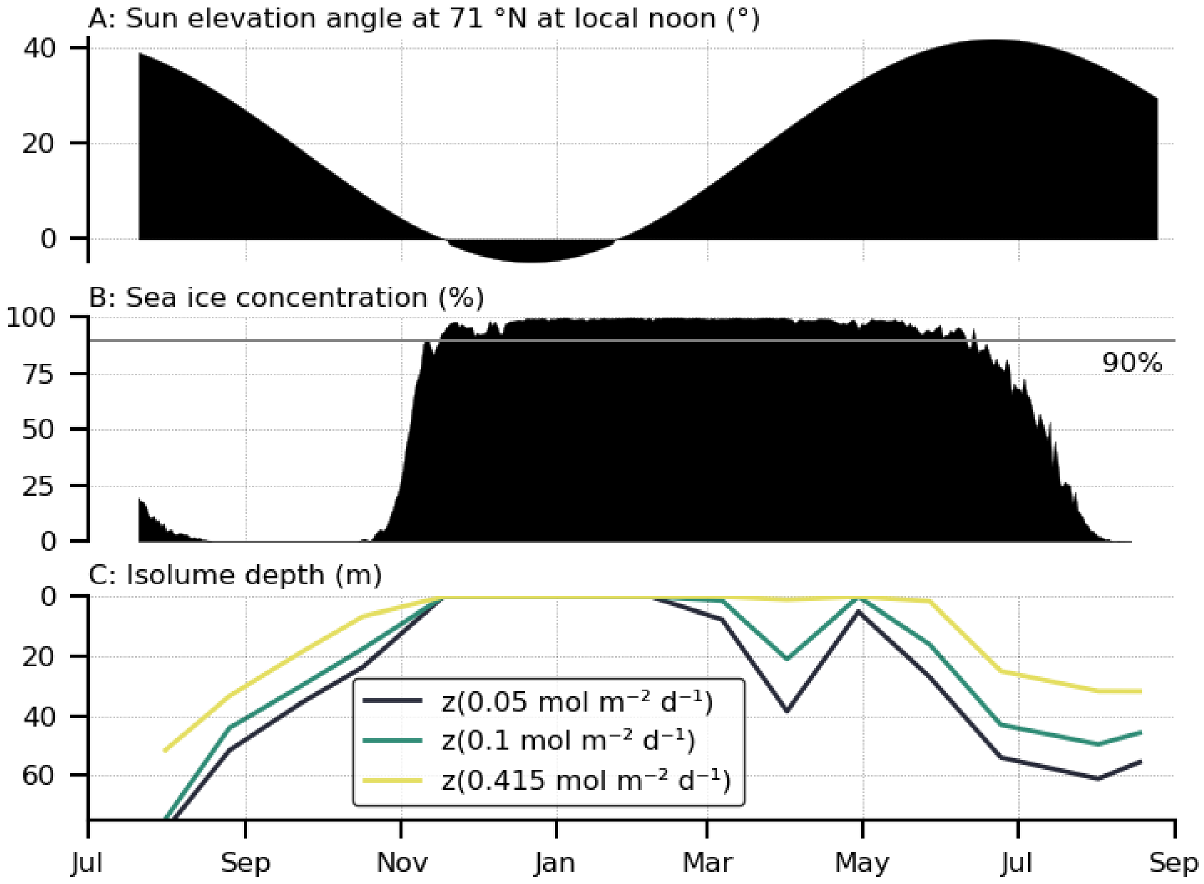
Randelhoff et al., in prep.

Polar night + sea ice/snow = little light

Sun elevation angle at local nooon

Sea ice concentration

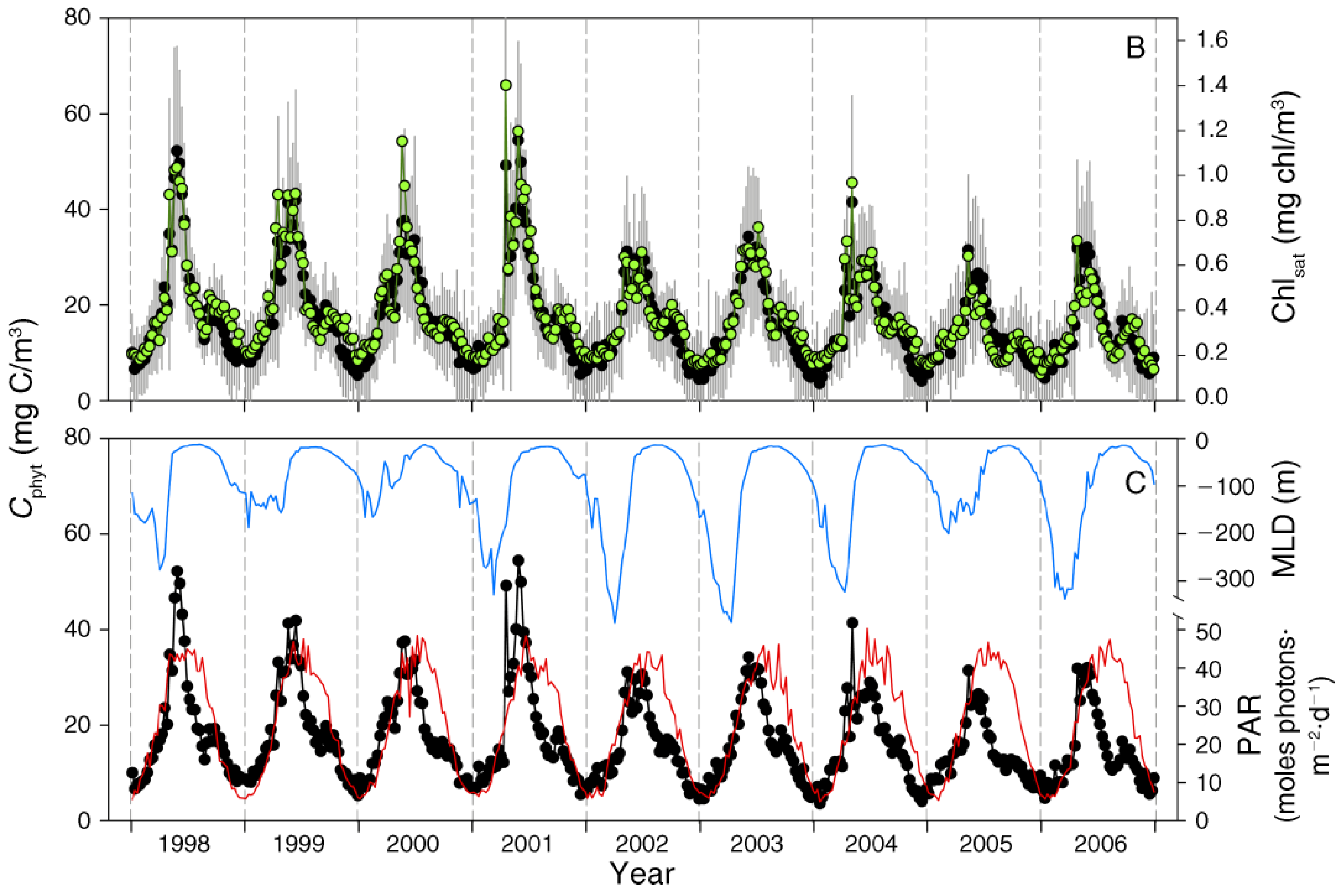
Isolume depths



Randelhoff et al., in prep.

2 conditions for winter biomass accumulation: low respiration and low grazing

At low latitudes, made possible by deep-mixing (= dilution)



Behrenfeld (2010)

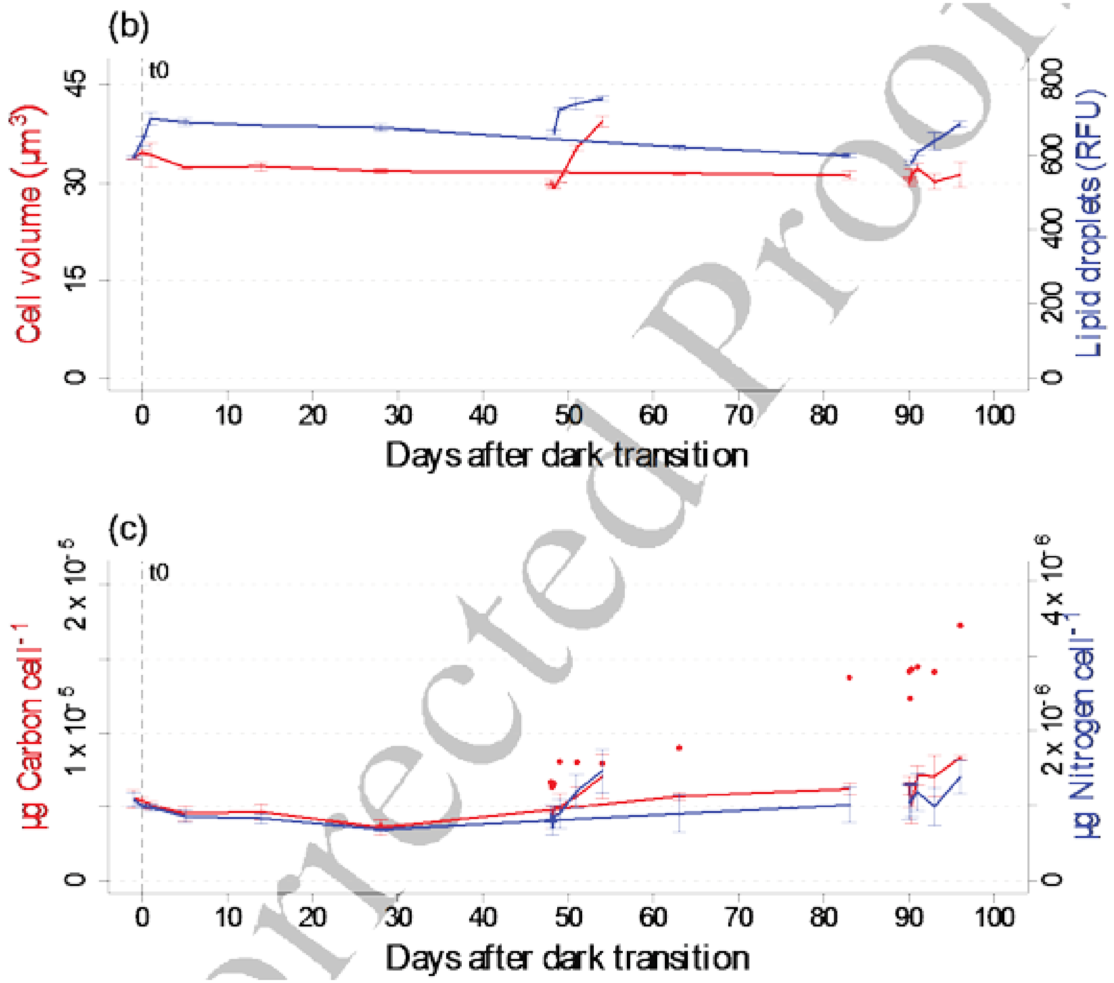
LIMNOLOGY
and
OCEANOGRAPHY

Limnol. Oceanogr. 00, 2019, 1–20

doi: 10.1002/lno.11368

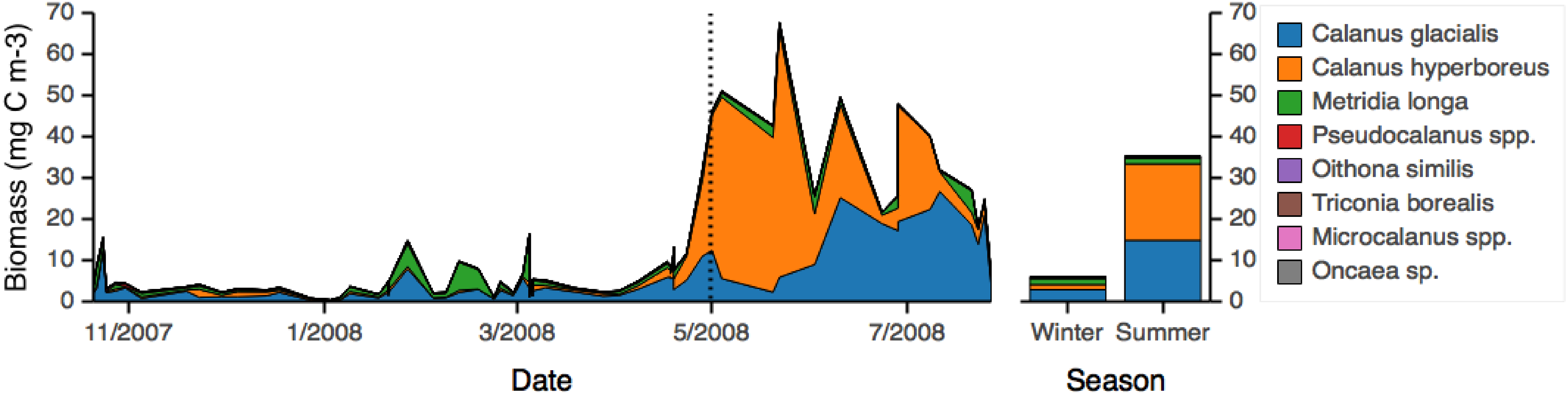
Response of the sea-ice diatom Fragilariopsis cylindrus to simulated polar night darkness and return to light

Morin et al. (in press)



In Arctic, respiration in microalgae may indeed be very low

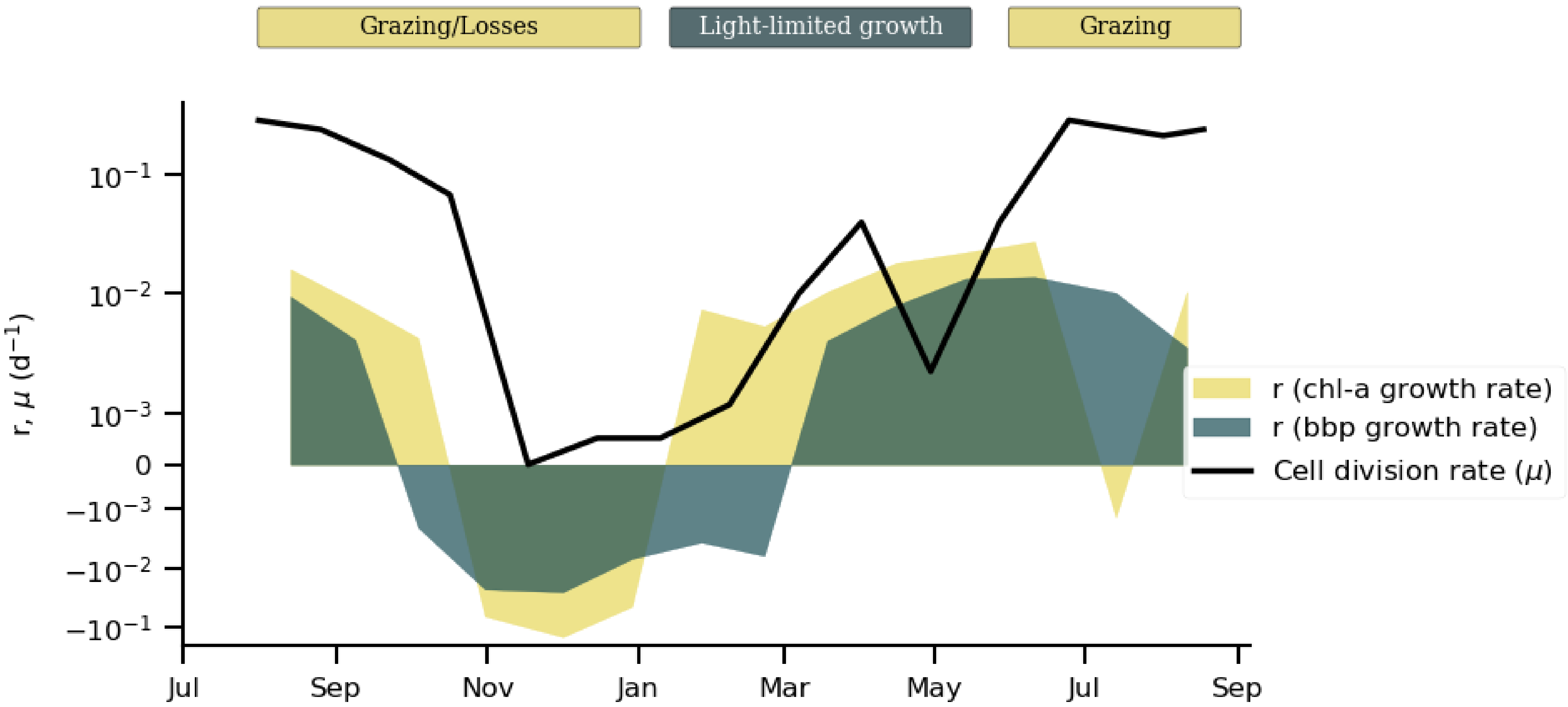
(Almost) no zooplankton grazing in winter



Data source: Circumpolar Flaw Lead project, 2007-08

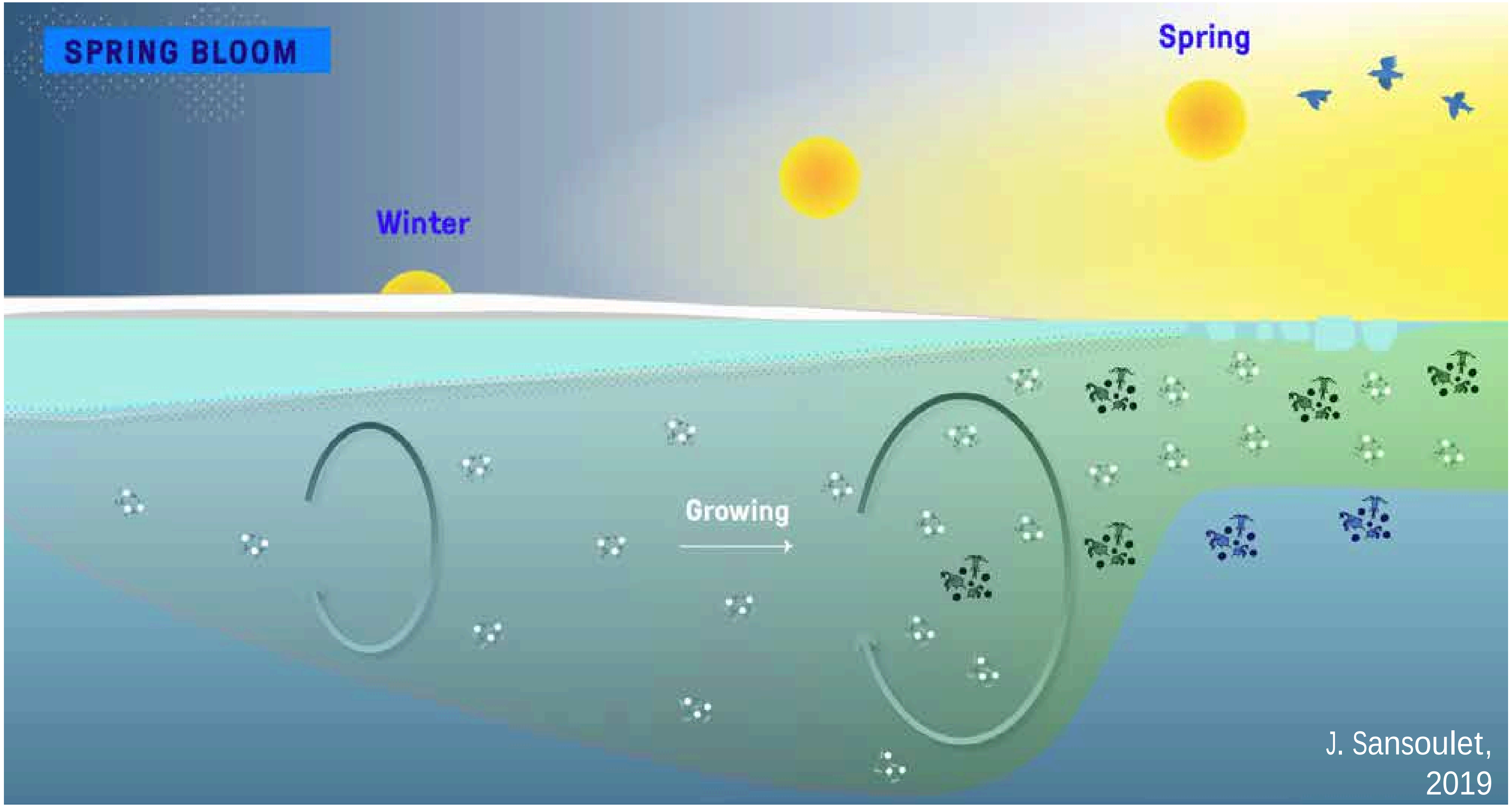
Gerald Darnis

Winter bloom initiation:
Positive growth rates in mid-winter



Randelhoff et al., in prep.

The ice edge/spring bloom is linked to what's happening during winter



SCIENCE ADVANCES | RESEARCH ARTICLE

OCEANOGRAPHY

Arctic mid-winter phytoplankton growth revealed by autonomous profilers

Achim Randelhoff[1,2]*, Léo Lacour[1,2], Claudie Marec[1,3], Edouard Leymarie[4], José Lagunas[1,2]†, Xiaogang Xing[5], Gérald Darnis[1,2], Christophe Penkerc'h[4], Makoto Sampei[6], Louis Fortier[1,2], Fabrizio D'Ortenzio[4], Hervé Claustre[4], Marcel Babin[1,2]

It is widely believed that during winter and spring, Arctic marine phytoplankton cannot grow until sea ice and snow cover start melting and transmit sufficient irradiance, but there is little observational evidence for that paradigm. To explore the life of phytoplankton during and after the polar night, we used robotic ice-avoiding profiling floats to measure ocean optics and phytoplankton characteristics continuously through two annual cycles in Baffin Bay, an Arctic sea that is covered by ice for 7 months a year. We demonstrate that net phytoplankton growth occurred even under 100% ice cover as early as February and that it at least partly resulted from photosynthesis. This highlights the adaptation of Arctic phytoplankton to extreme low-light conditions, which may be the key to their survival before seeding the spring bloom.

25 September 2020

Thank you for your attention!

NAOS
Novel Argo Ocean observing System

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Sentinelle Nord

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GREEN EDGE

poplarshift.github.io