Unravelling the dynamics of pelagic ecosystems by quantitative observation of **morphological attributes of marine snow:** a case study in the Arctic.

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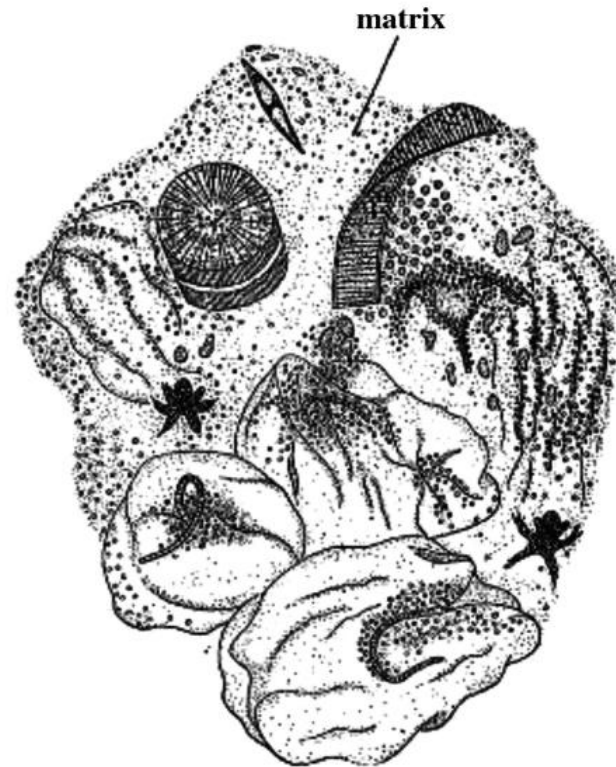[3] Institute for Ecosystem Research, Kiel University, Kiel, Germany
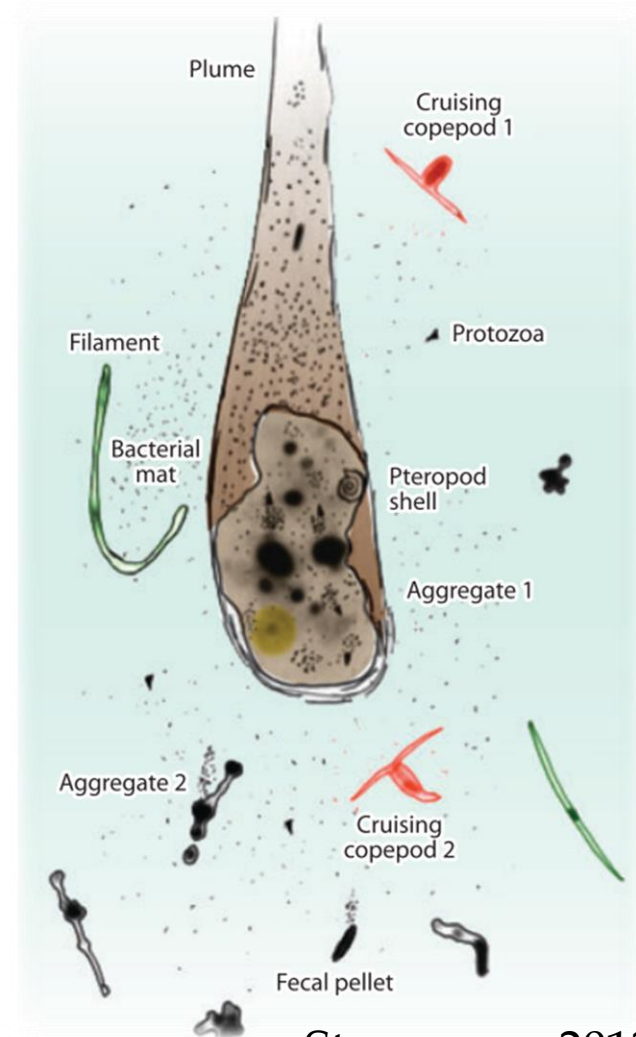[4] Alfred Wegener Institute, Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany
[5] Sorbonne Université, CNRS, UMR 7093, Laboratoire d'Océanographie de Villefranche-sur-Mer (LOV), Villefranche-sur-Mer, France
[6] Dalhousie University Halifax, Nova Scotia, Canada
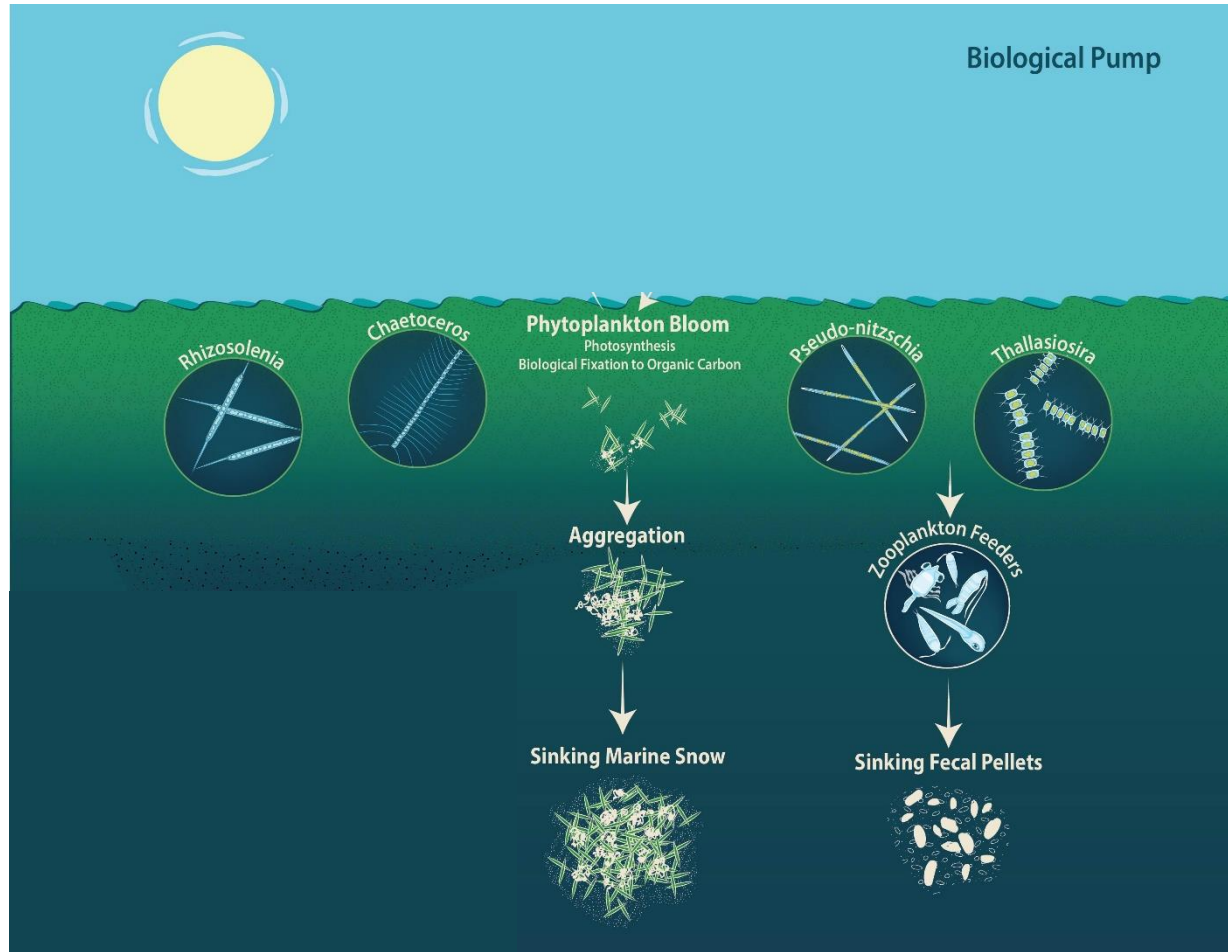
marine snow

matrix

Fig. 2. Drawing of near-surface marine snow ("nuta") and its contents, from waters adjacent to the most southerly of the islands of Japan. Image shows phytoplankton and other small organisms (possibly nauplii and Noctiluca) in the marine snow, collected and illustrated in Tsujita's publication from 1953.
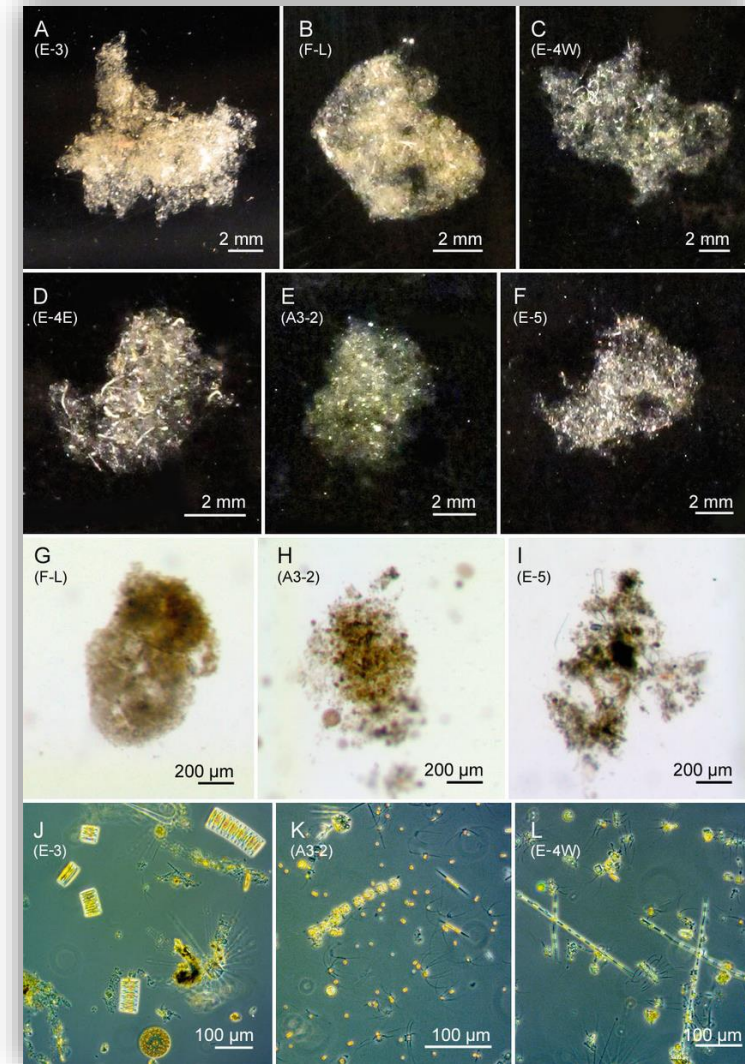
Plume

Cruising copepod 1

Filament

Protozoa

Bacterial mat

Pteropod shell

Aggregate 1

Aggregate 2

Cruising copepod 2

Fecal pellet

Stemmann, 2012

morphological attributes of marine snow

@Natalie Renier

Laurenceau-Cornec et al. 2015

Goals

Summer 2016

Baffin Bay   Fram Strait
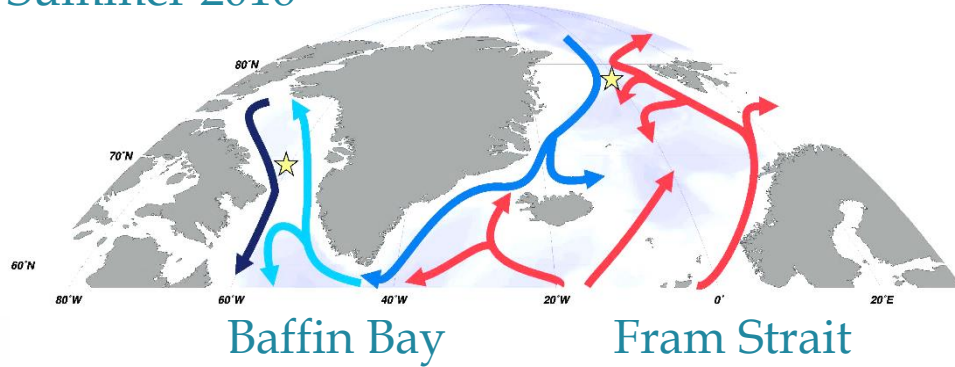
to develop a simple approach to automatically classify marine snow images taken by Underwater Vision Profiler according to their morphology in two key Arctic locations
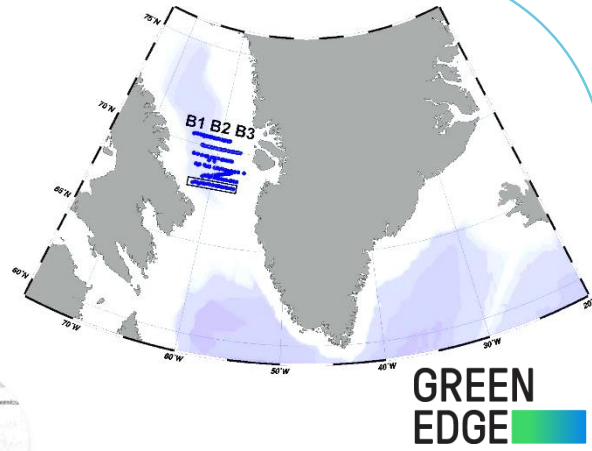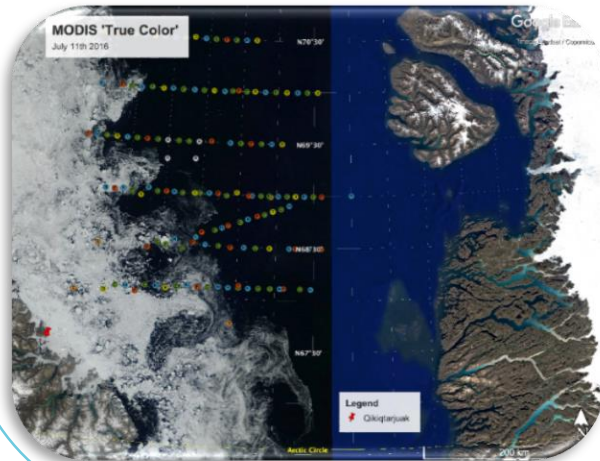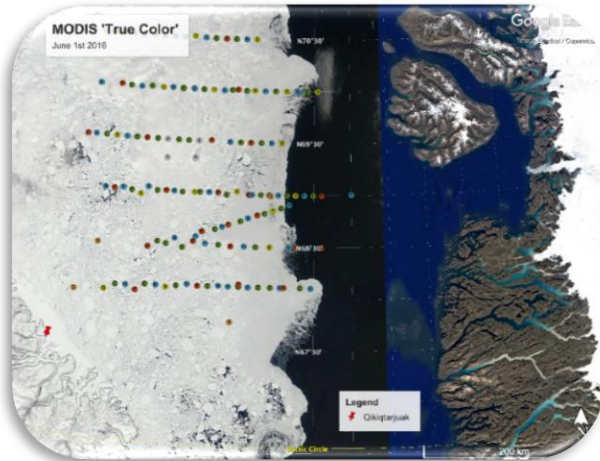
to follow the spatio-temporal modifications in morpho-traits of marine snow during specific productivity phases

to infer about vertical export of specific morpho-types of marine snow
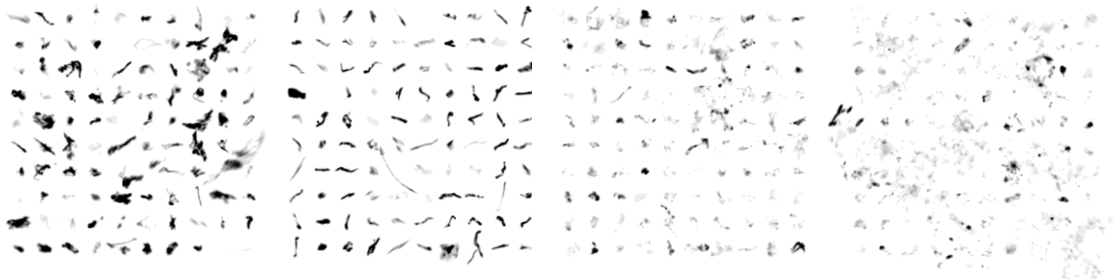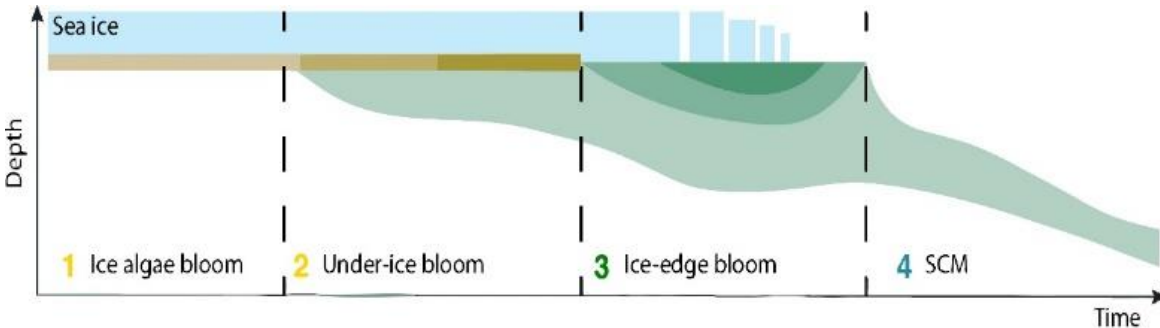
Baffin Bay

OWD : Open Water Days

164 stations

3 Periods:

B1: < -10 OWD

B2: > -10 < +10 OWD

B3: > + 10 OWD

Randelhoff et al. 2019

Fram Strait

26 stations

3 Periods:
EGC - ICE
WSC - F1
WSC – F2
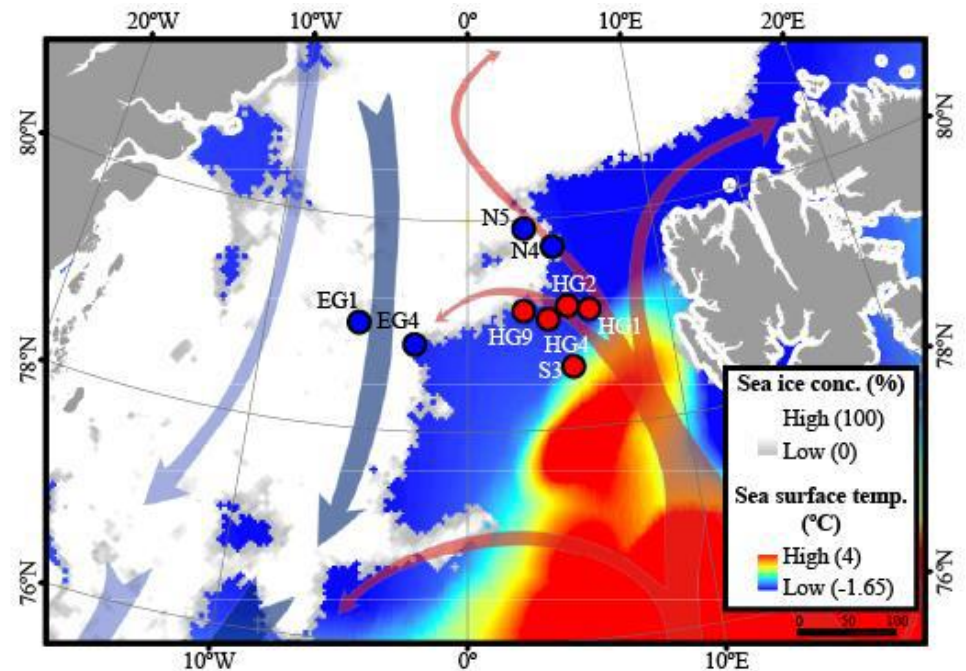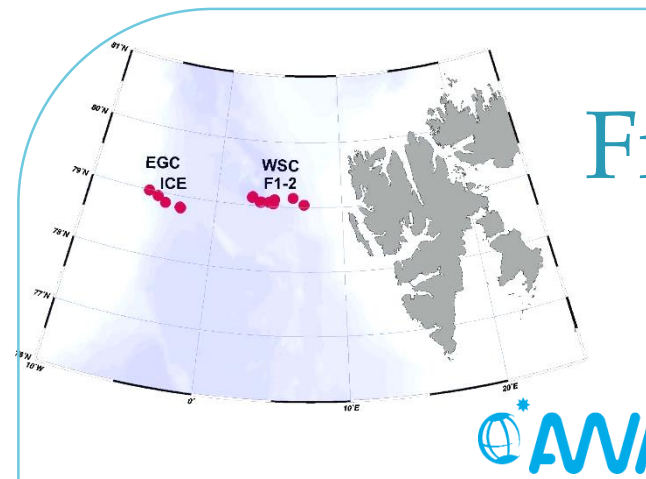
Fadeev et al. in prep.

In situ images

UVP : Underwater Vision Profiler
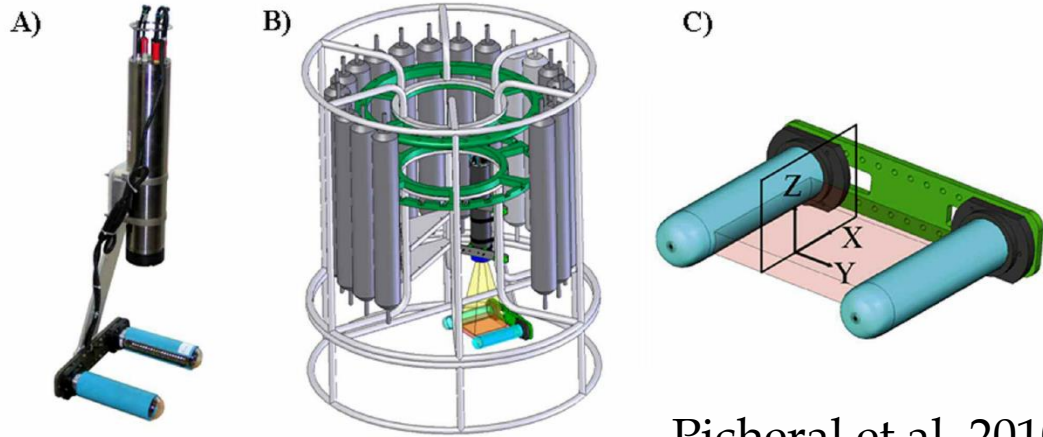
Picheral et al. 2010

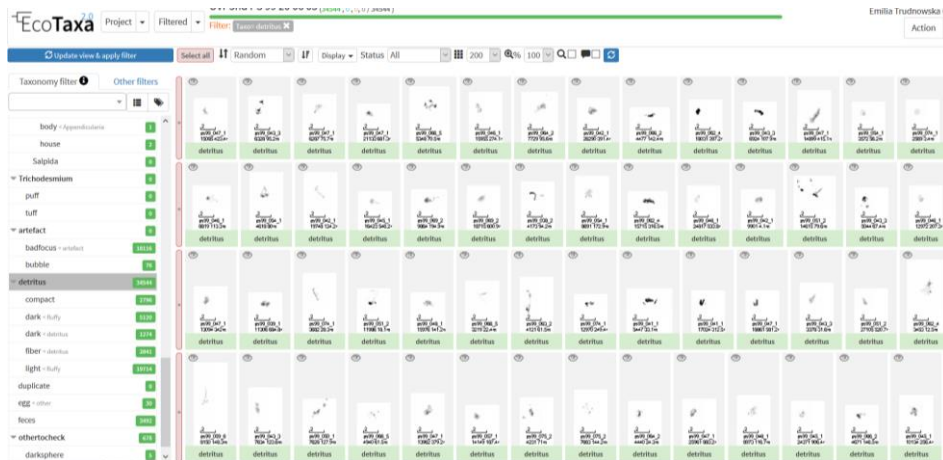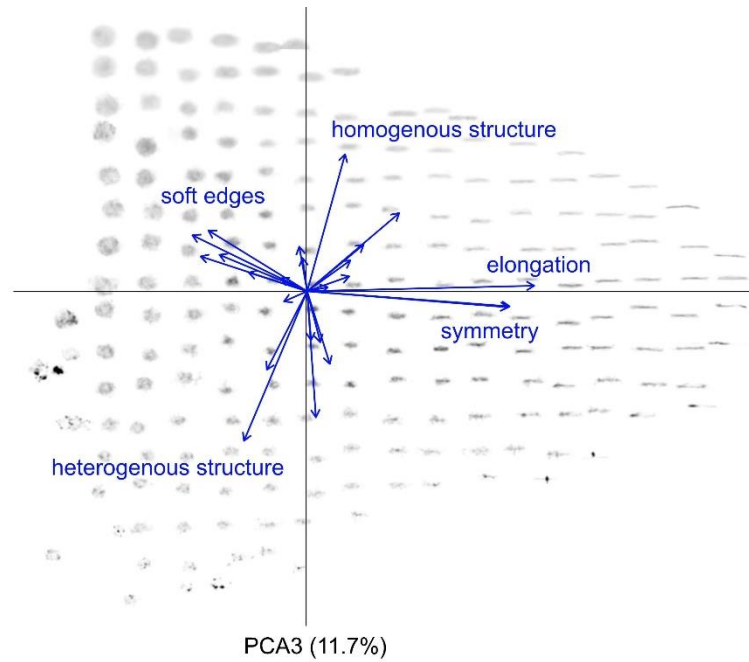## ECOTAXA – 1 131 184 vignettes

PCA :
24 morphological traits of every single marine snow particle
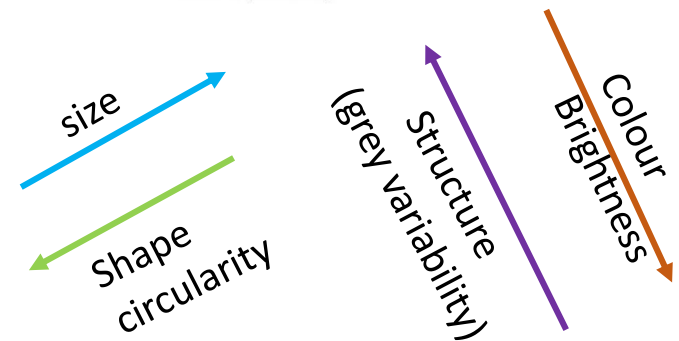
Morpho-clusters of marine snow
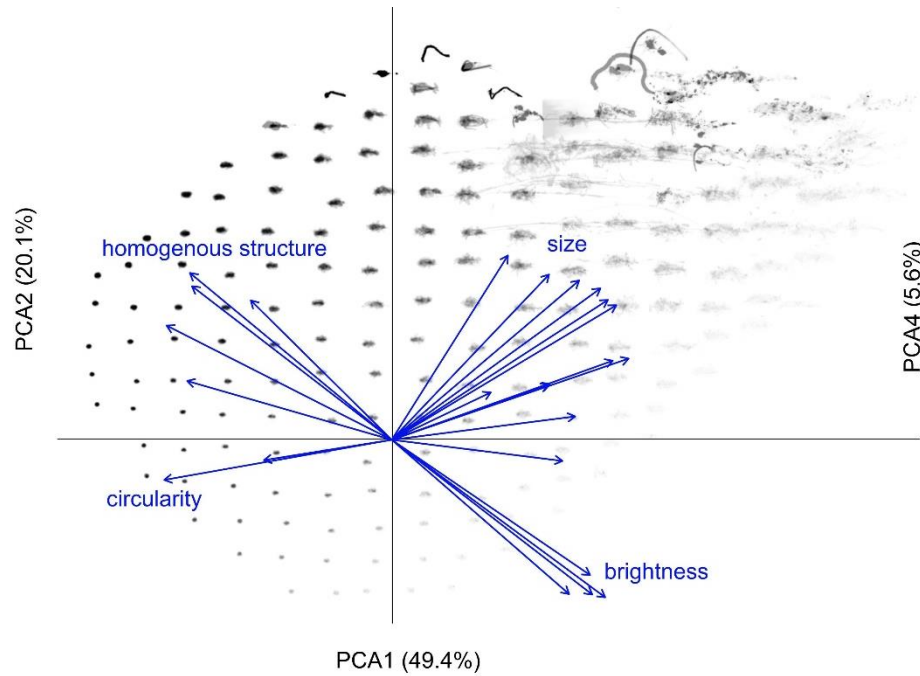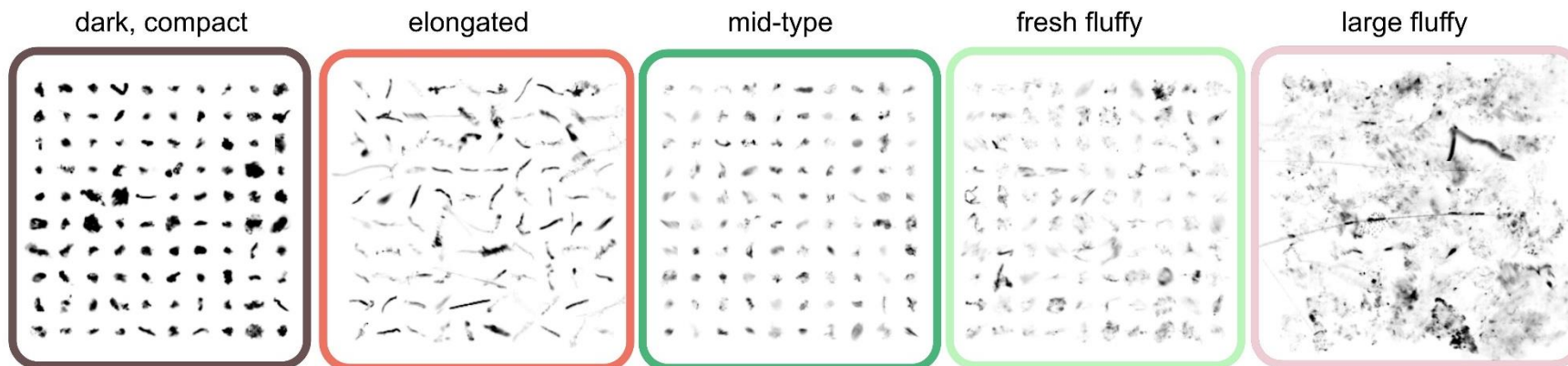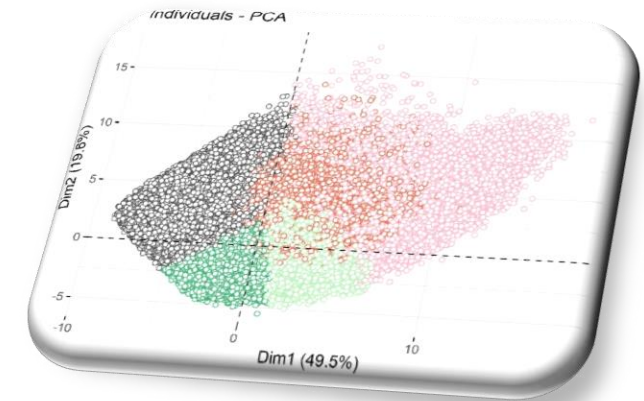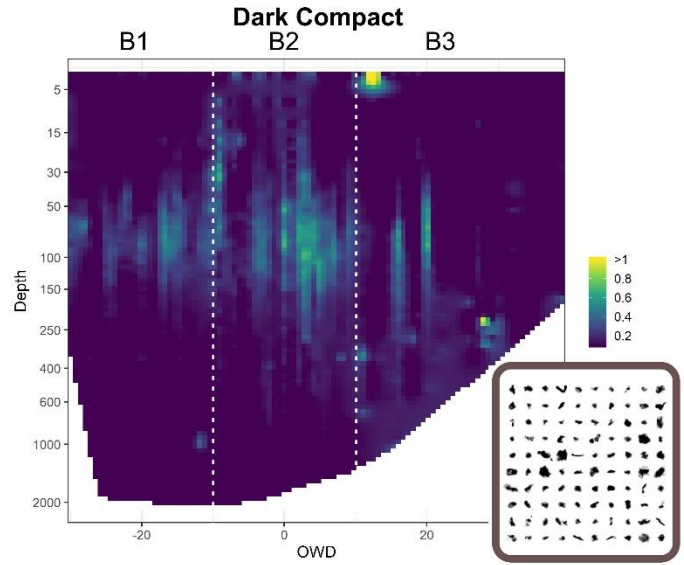
homogenous structure

size

circularity

brightness

PCA2 (20.1%)

PCA1 (49.4%)

homogenous structure

soft edges

elongation

symmetry

heterogenous structure

PCA4 (5.6%)

PCA3 (11.7%)

K-means clustering

individuals - PCA

Dim2 (19.6%)

Dim1 (49.5%)

dark, compact

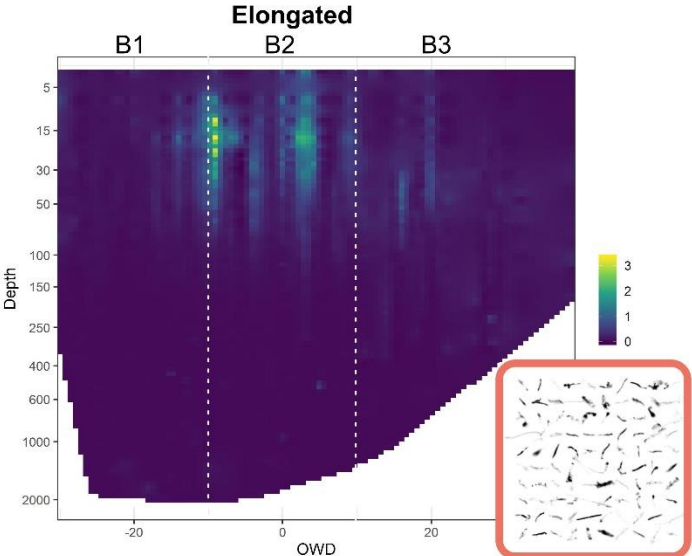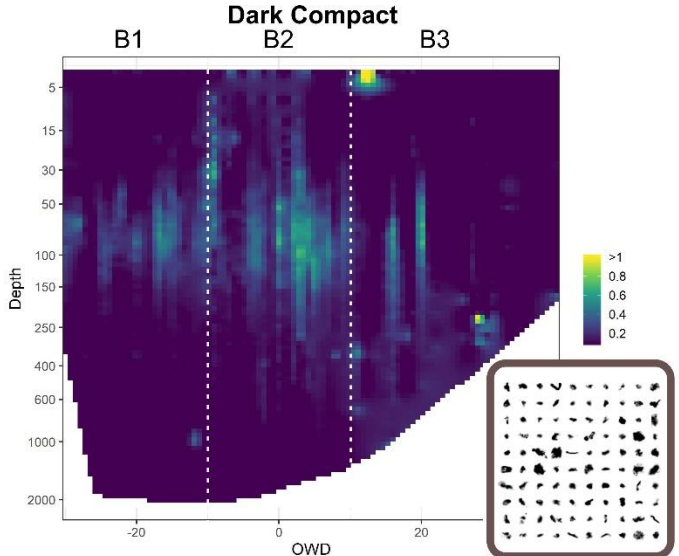elongated

mid-type

fresh fluffy

large fluffy

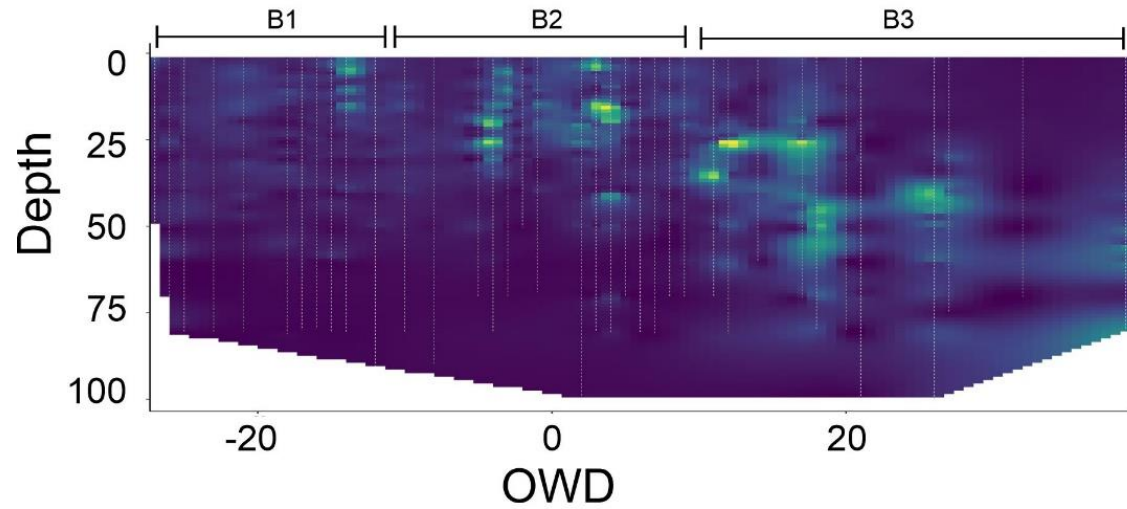# Time series of marine snow morpho-clusters
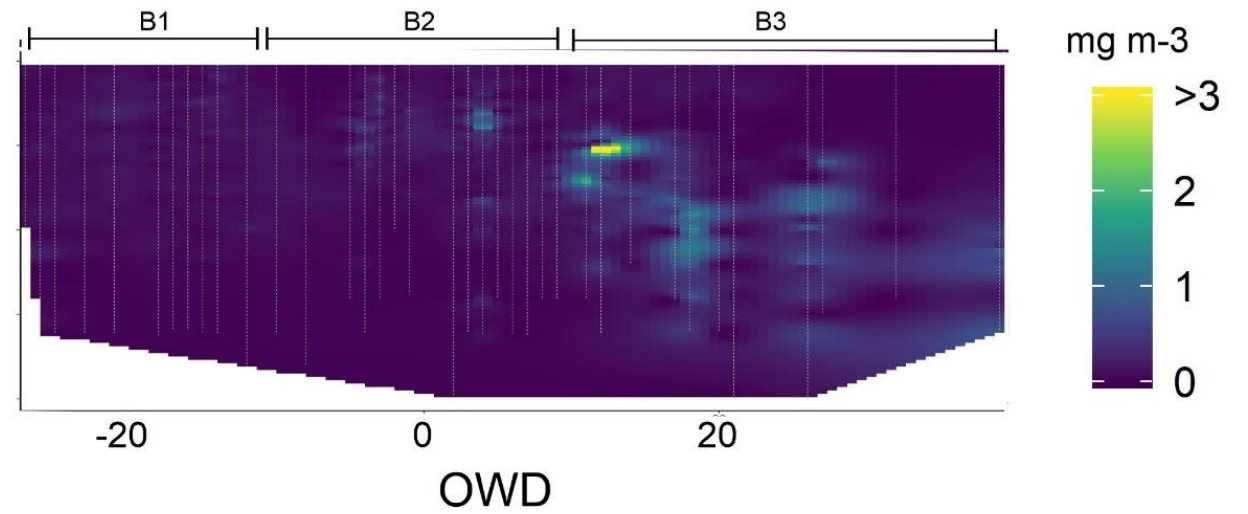
Time series of marine snow morpho-clusters
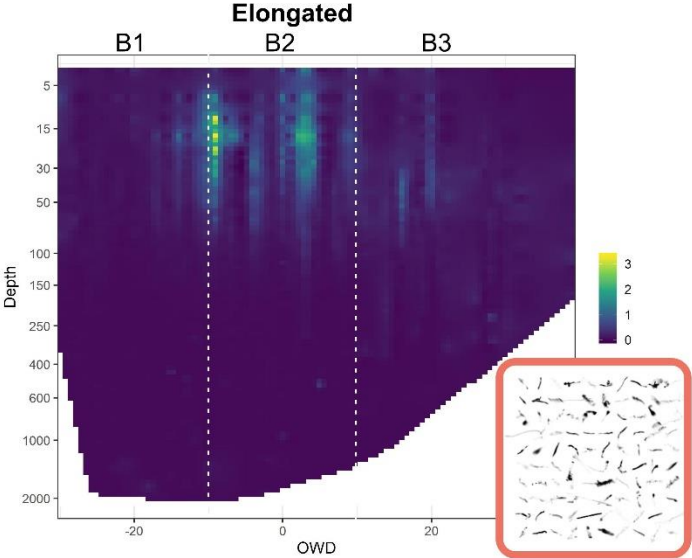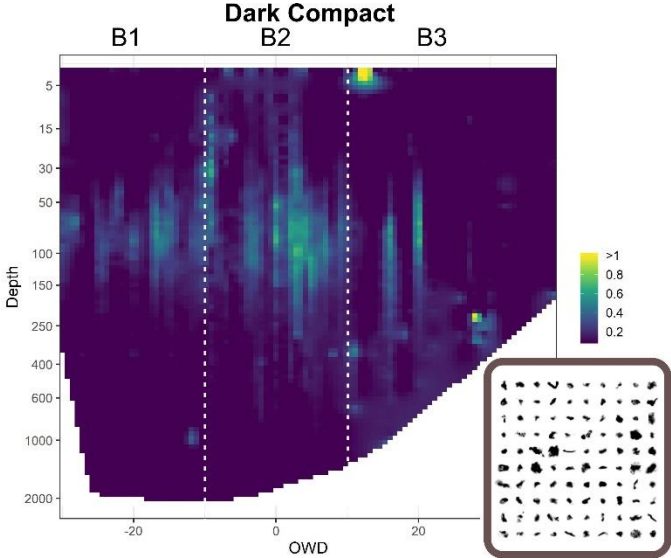
Time series of marine snow morpho-clusters
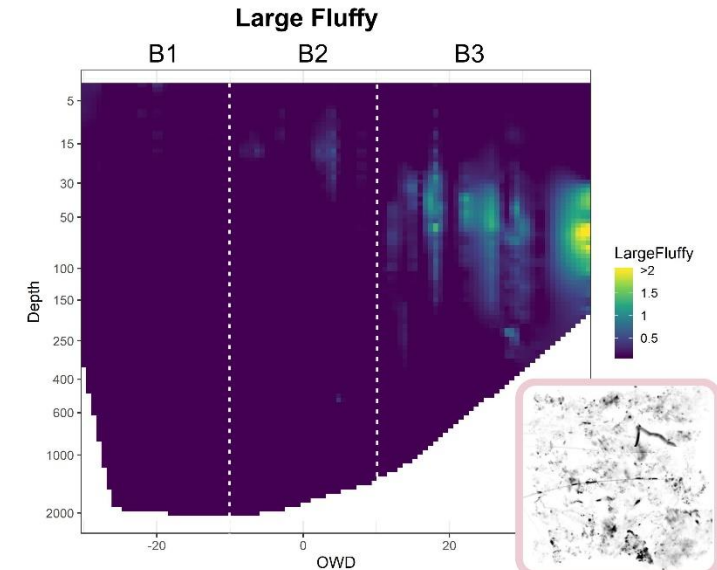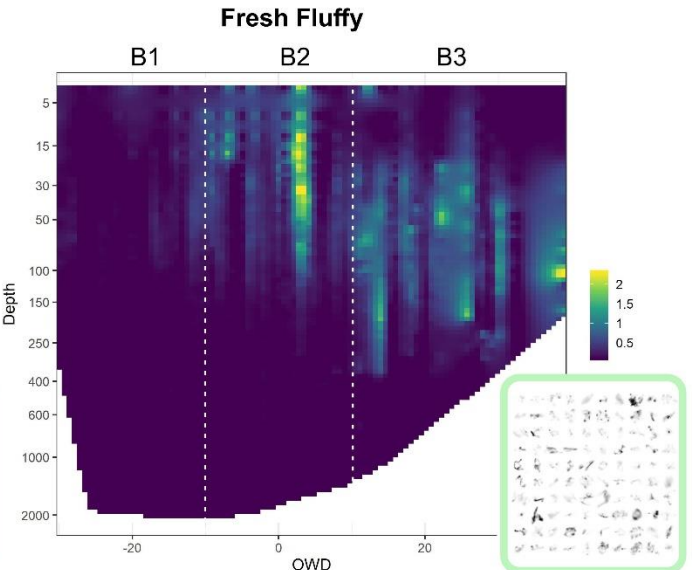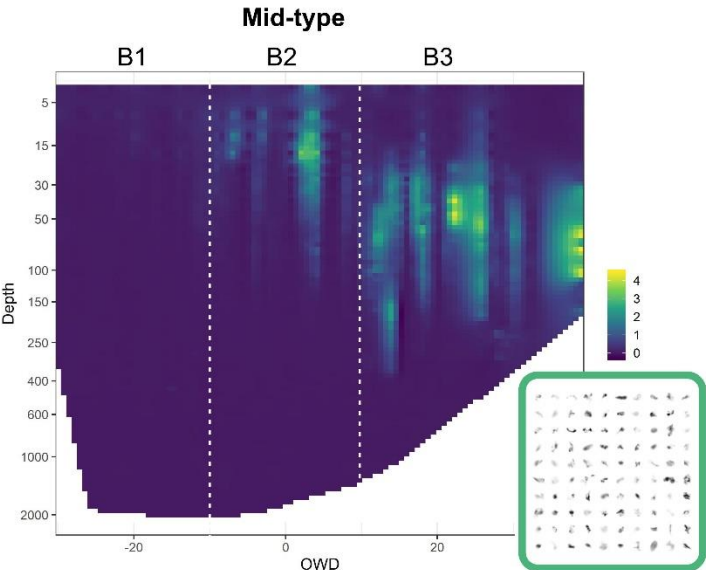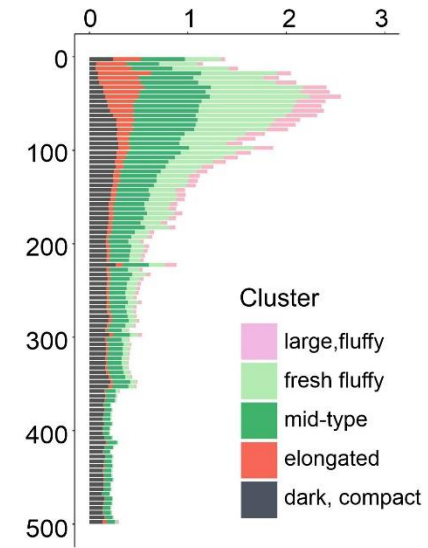
Time series of phytoplakton

Diatoms

Phaeocystis

Phytoplankton vs. marine snow composition
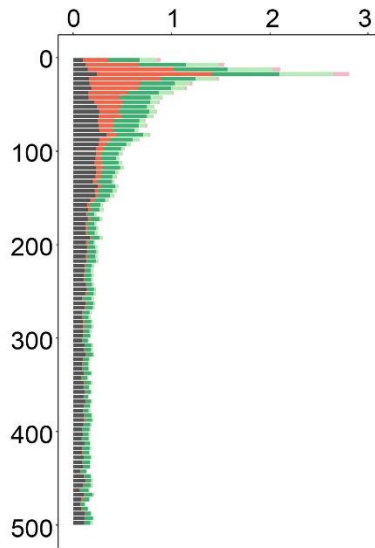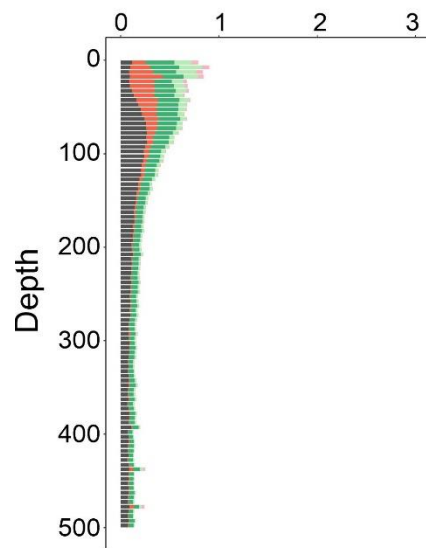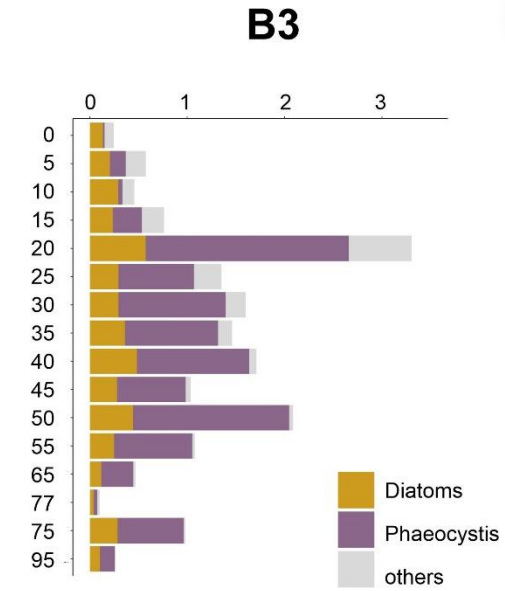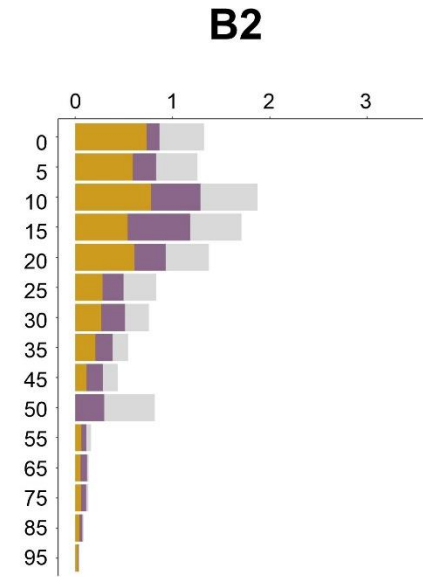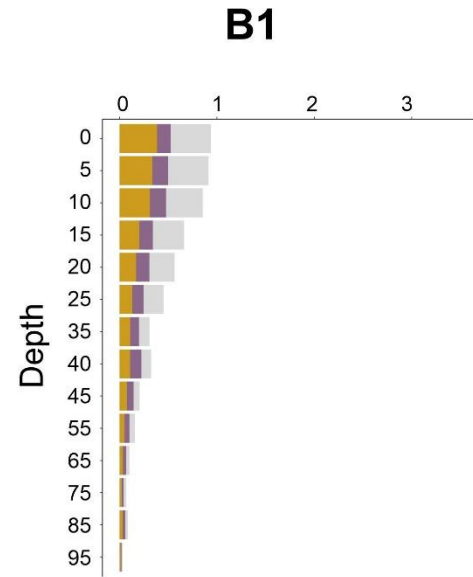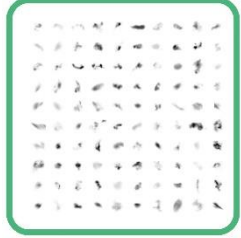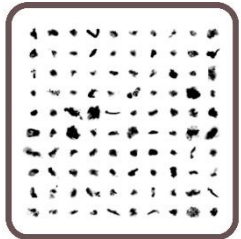
Marine snow composition vs. zooplankton

Vilgrain et al.
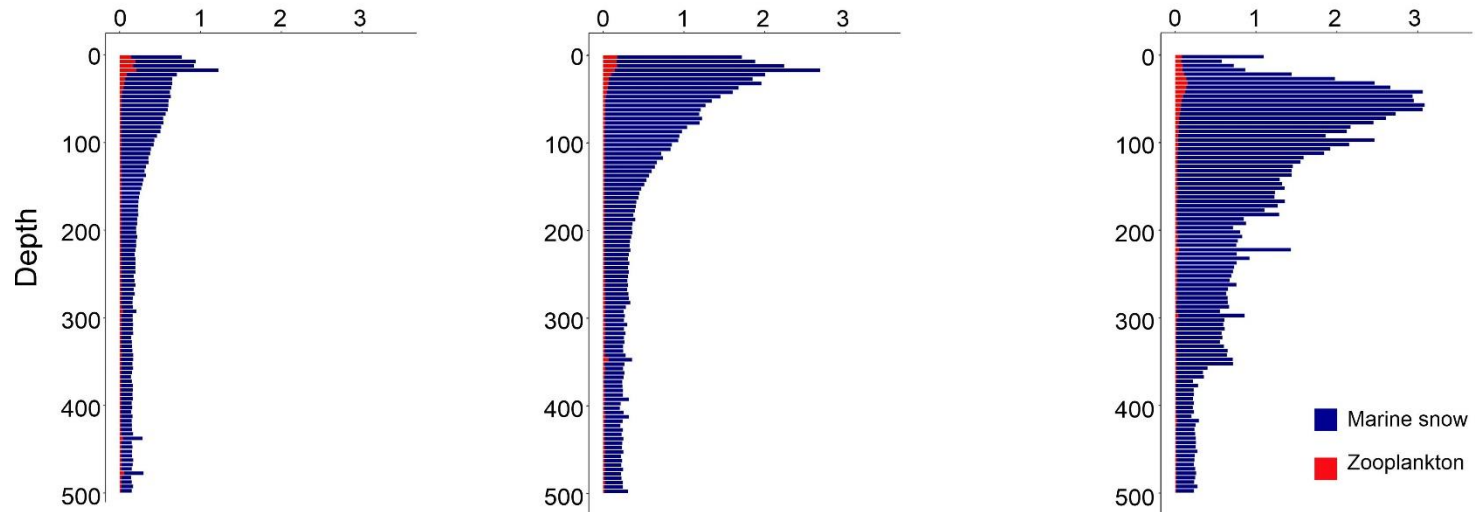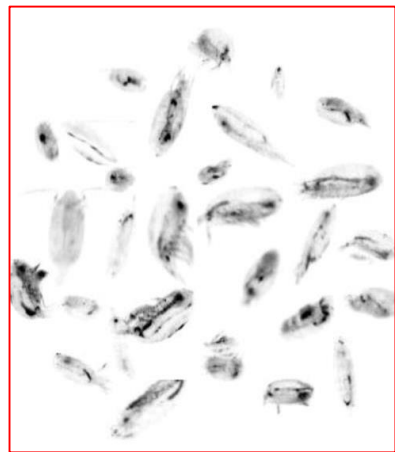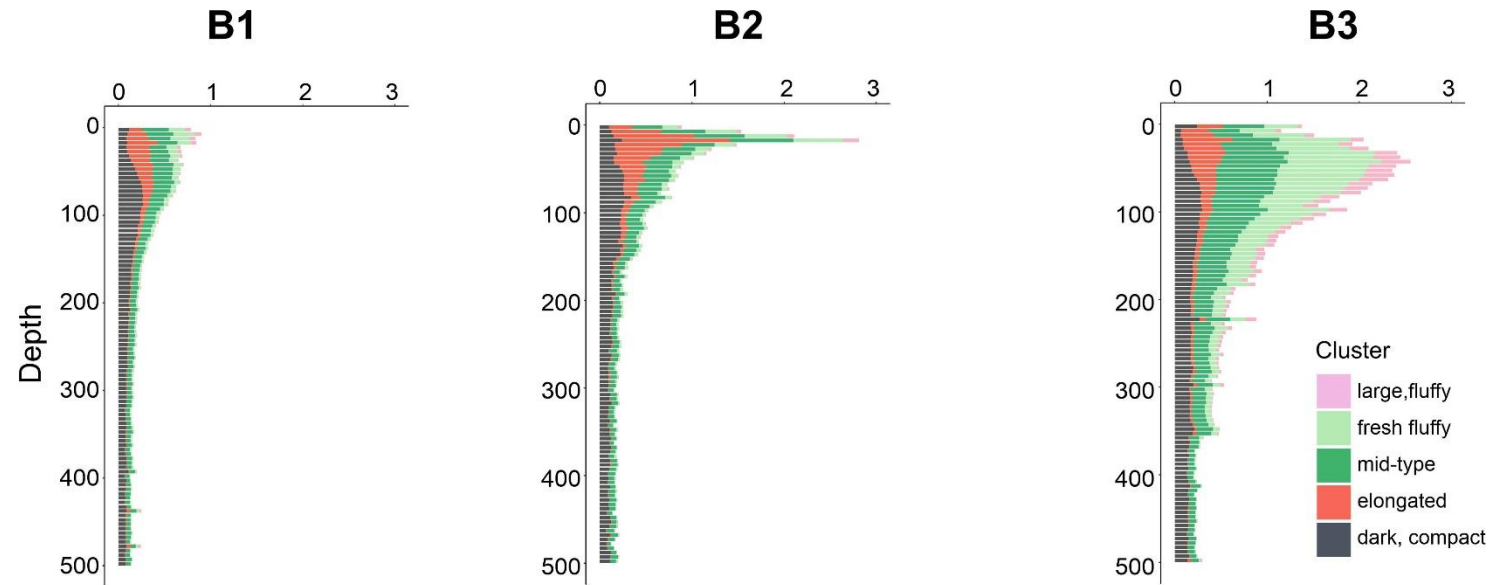
Baffin Bay vs. Fram Strait
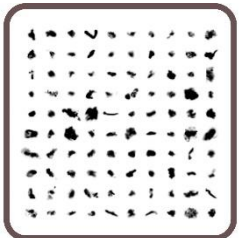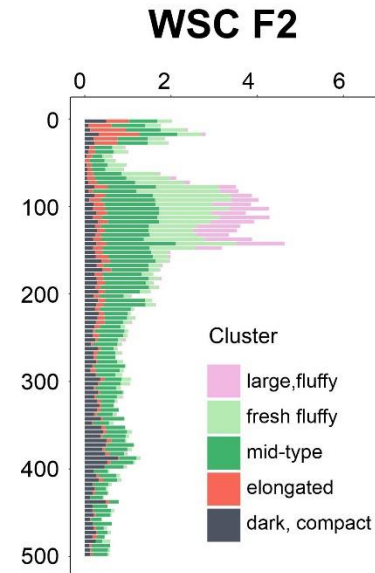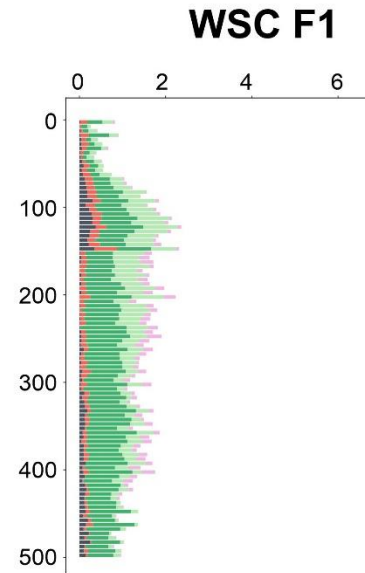
Phytoplankton

Marine snow

Zooplankton
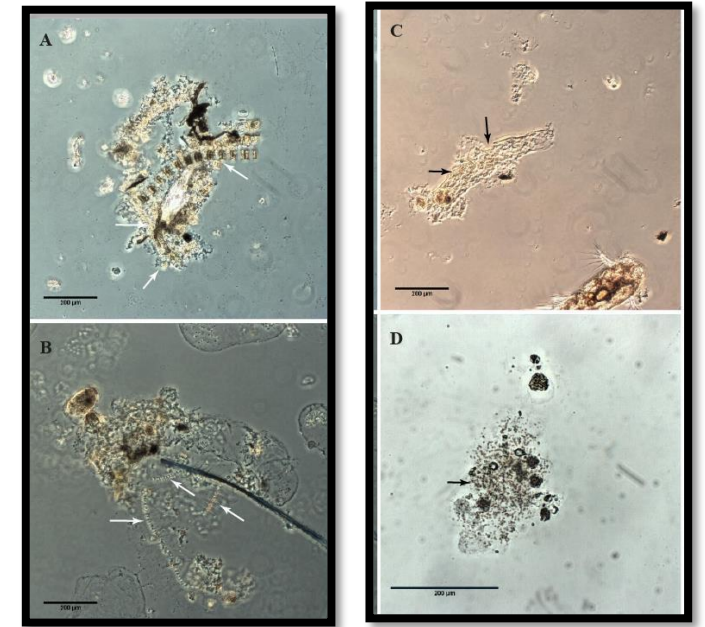
Fadeev et al. in prep.

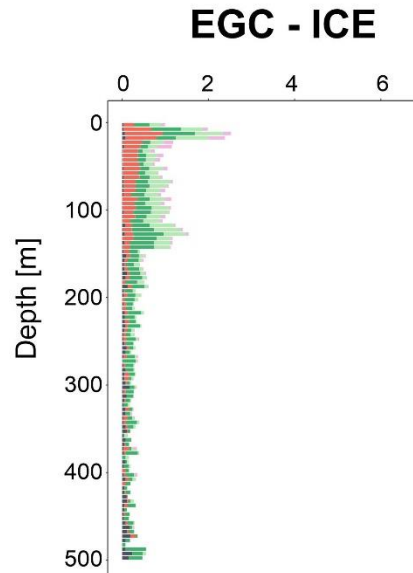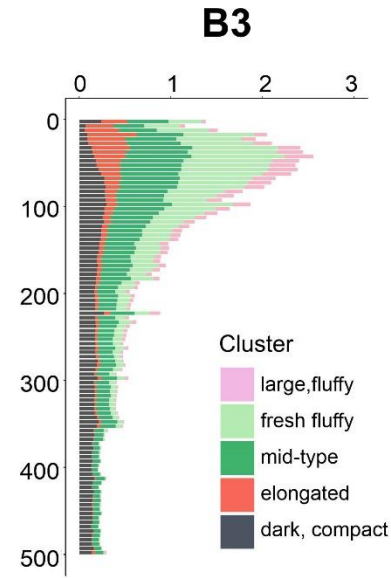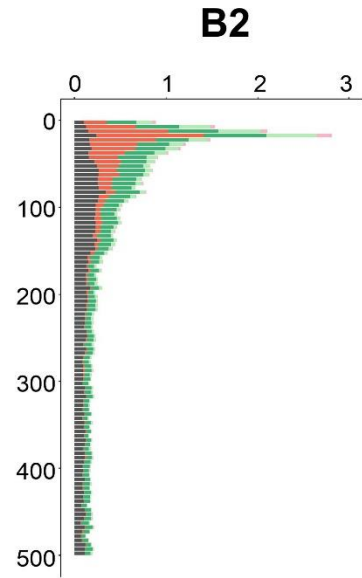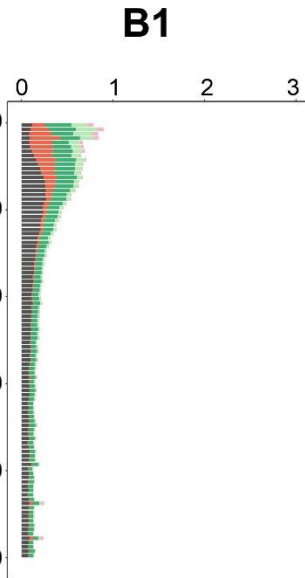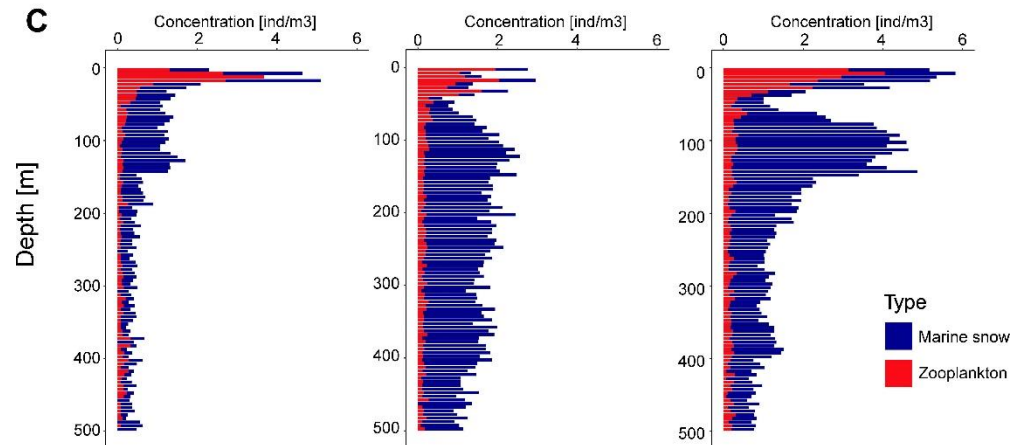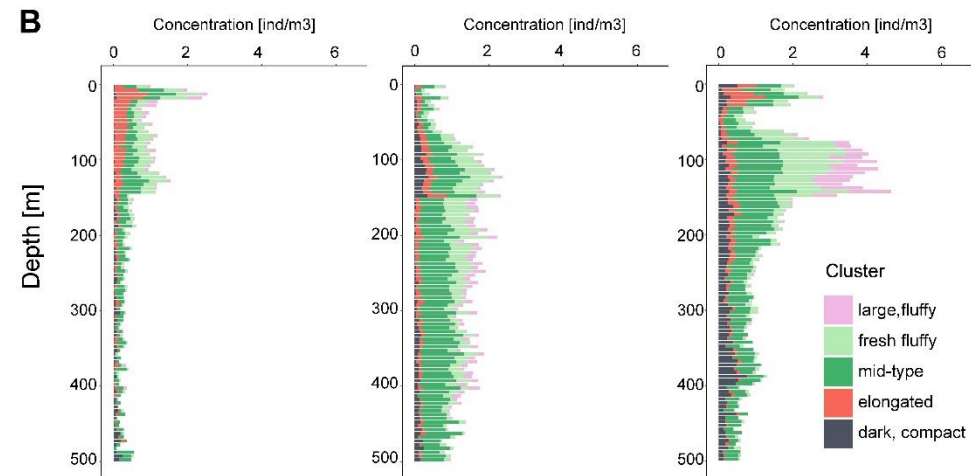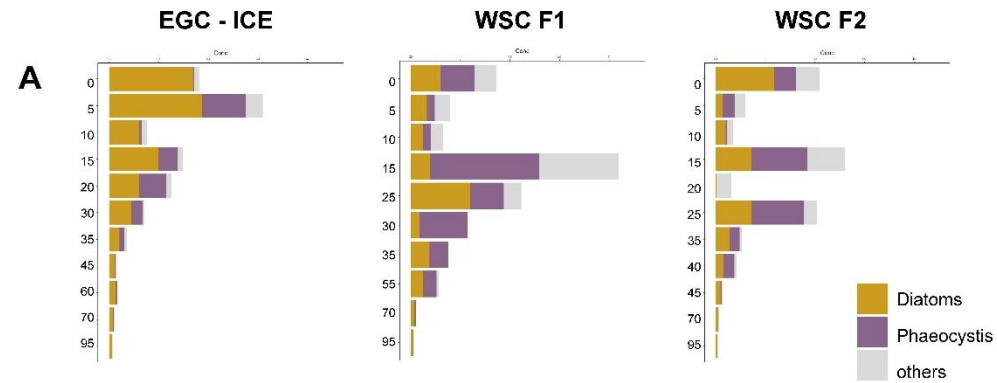A multi-process spectacle extended over time and space

Ice algea

stratification

export to the benthos
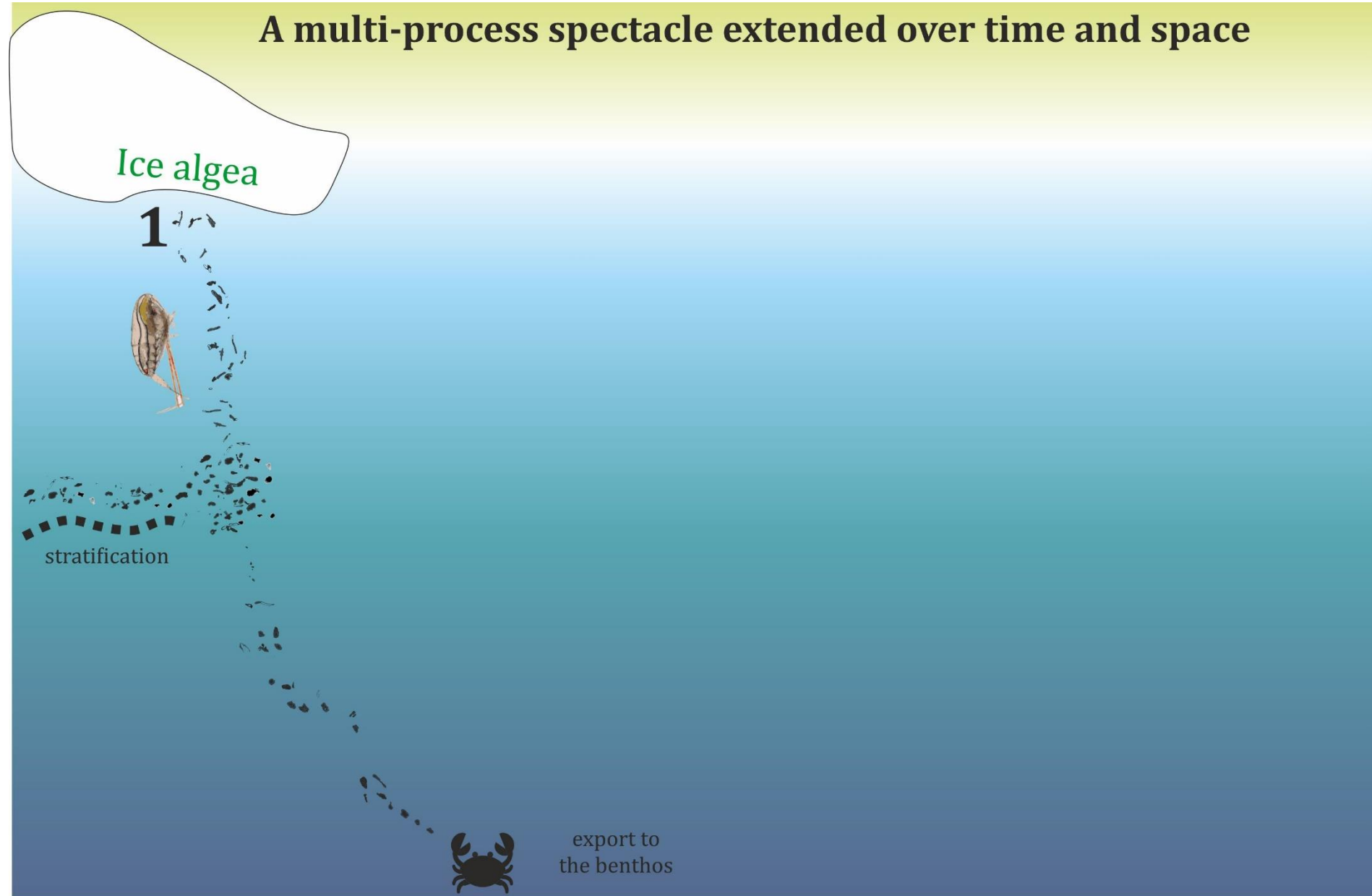
1. under ice bloom

A multi-process spectacle extended over time and space

Ice algea

Diatoms

sea ice collapse

stratification

export to the benthos
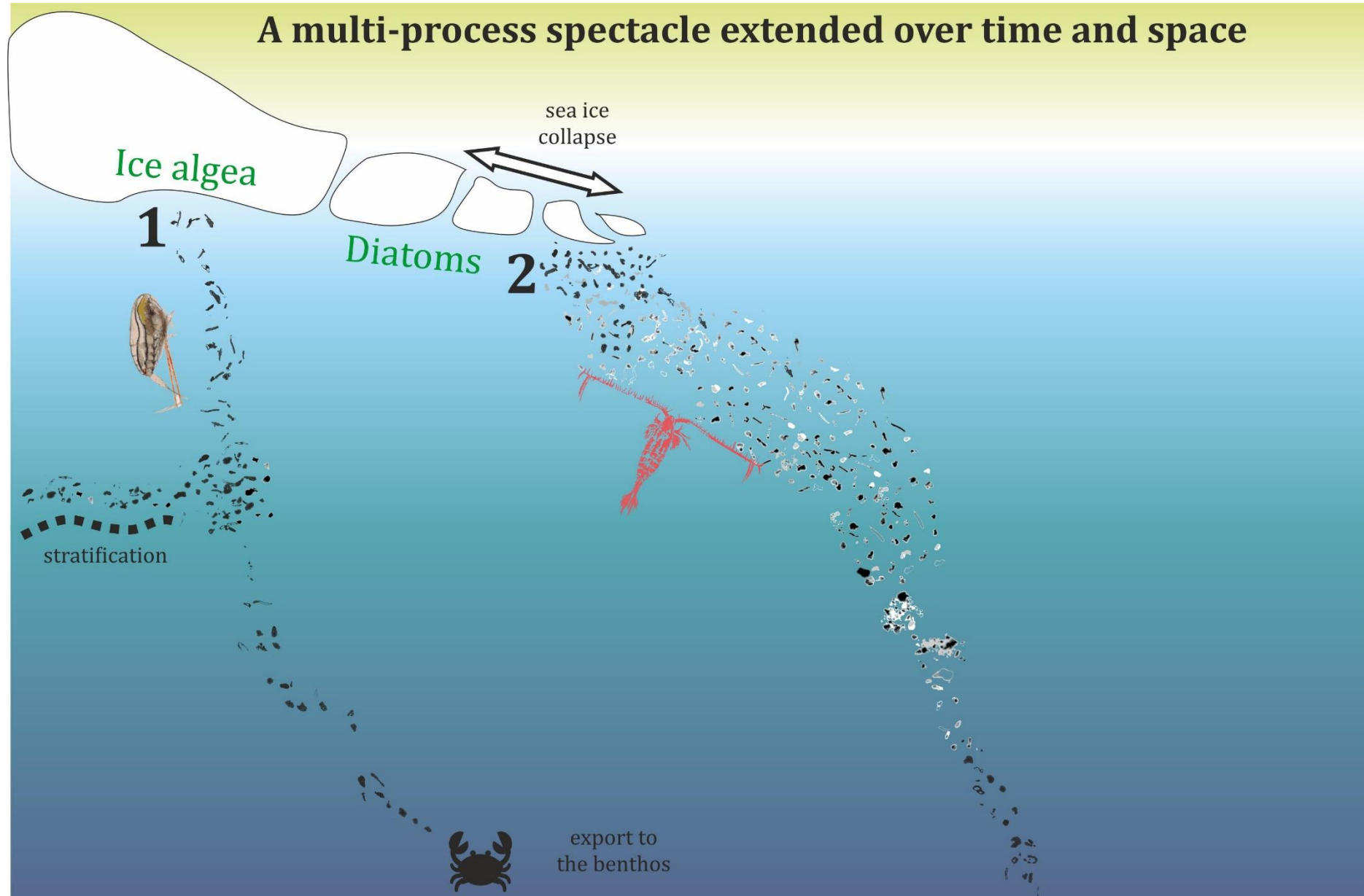
1. under ice bloom   2. ice edge bloom

A multi-process spectacle extended over time and space

Ice algea

sea ice collapse

Diatoms

Phaeocystis

1

2

3

stratification

export to the benthos
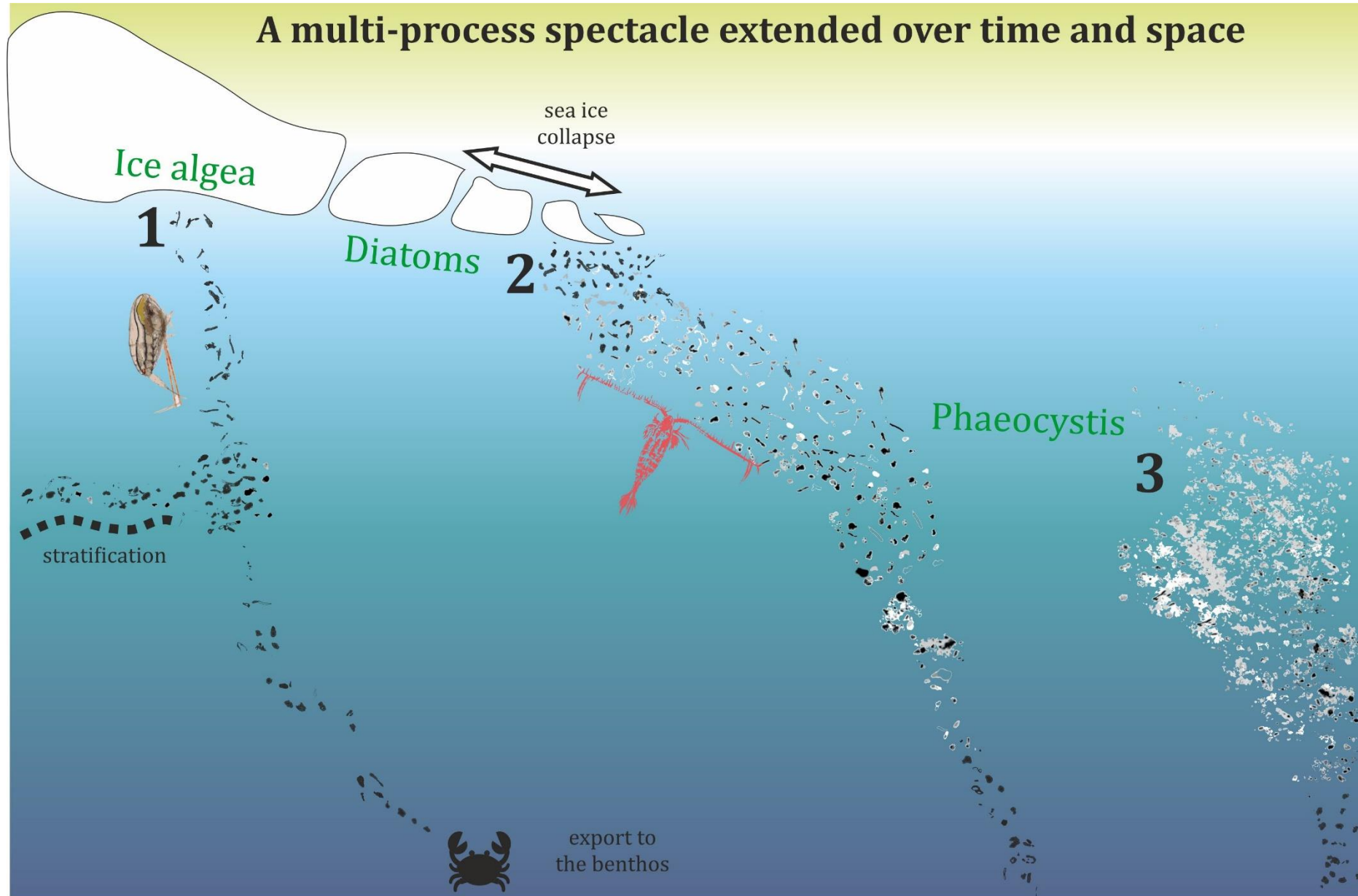
1. under ice bloom   2. ice edge bloom   3. advanced bloom
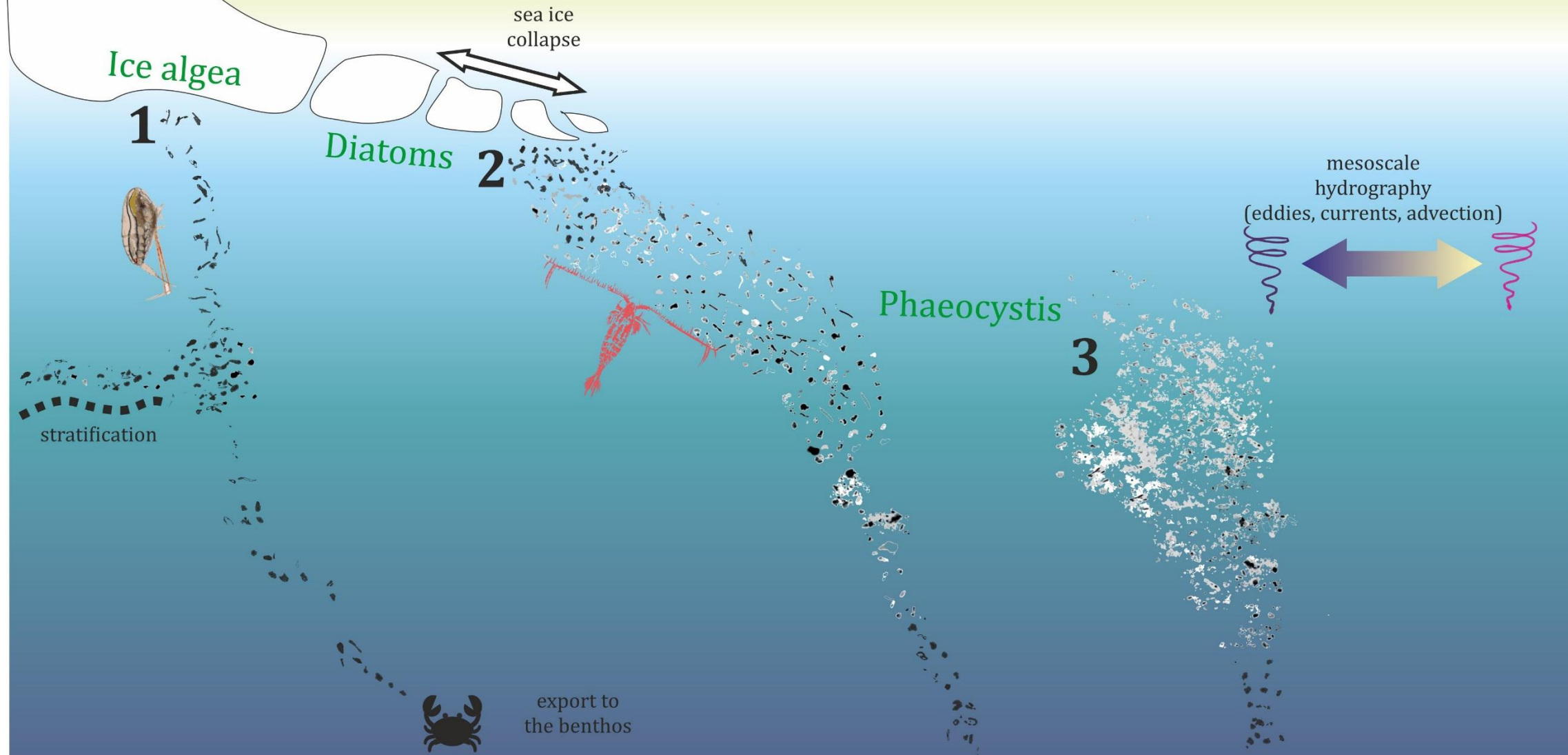
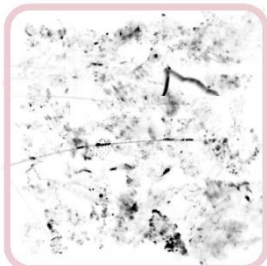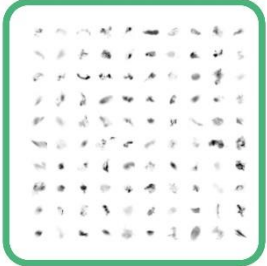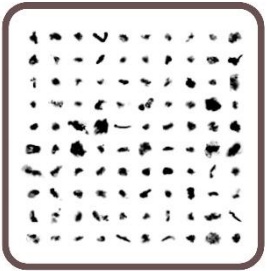A multi-process spectacle extended over time and space

1. under ice bloom   2. ice edge bloom   3. advanced bloom

Take home

- 'automatic' method by clustering - useful and reliable approach for following morphological changes in marine snow

- morphology of marine snow is clearly reflecting the successive bloom stages

- The occurrence of *Phaeocystis* is dramatically changing the structure/composition of marine snow. Those large, heterogeneous conglomerates are exported over 300 m

- Elongated forms (diatoms/feacal pellets) seem to be the least important component of the export

- The particles that reach the sea bottom are rather small, compact and dark.