Structure of the zip folder “Forgereau_2023”:

```
|
+---Svalbard Field
|  |
|  +---Environmental data
|  |      Chl a Svalbard.csv
|  |      DIC Svalbard.csv
|  |      General Svalbard.csv
|  |      Salinity Svalbard.csv
|  |      Temperature Svalbard.csv
|  |      Bulk nutrients Svalbard.csv
|  |      Brine nutrients Svalbard.csv
|  |      Bulk POC/N Svalbard.csv
|  |      Brine POC/N Svalbard.csv
|  |
|  +---Community composition
|  |      TF1 composition Svalbard.csv
|  |      VM1 composition Svalbard.csv
|  |      VM2 composition Svalbard.csv
|  |      Composition 3 sites Svalbard.csv
|  |
|  \---PI curves field
|         TF1 PI Svalbard.csv
|         VM1 PI Svalbard.csv
|         VM2 PI Svalbard.csv
|
+---UiT Laboratory
|  |
|   +---Chl a
|   |      Chl a 10 UiT.csv
|   |      Chl a 33 UiT.csv
|   |      Chl a 33 vs 10 VM2 UiT.csv
|   |
|  +---Cell abundance
|   |      VM2 composition 4h10 UiT.csv
|   |      VM2 composition 24h10 UiT.csv
|   |      VM2 composition 168h10 UiT.csv
|   |      VM2 composition 4h33 UiT.csv
|   |      VM2 composition 24h33 UiT.csv
|   |      VM2 composition 168h33 UiT.csv
|   |      VM2 abundance 33 vs 10 UiT.csv
|   |
|   +---PI curves UiT
|   |  |
|   |  +--- PI curves 33 and 10
|   |  |        PI VM2 4h33 UiT.csv
|   |  |        PI VM2 24h33 UiT.csv
|   |  |        PI VM2 168h33 UiT.csv
|   |  |        PI VM2 4h10 UiT.csv
|   |  |        PI VM2 24h10 UiT.csv
```

```
|  |  |       PI VM2 168h10 UiT.csv
|  |  |
|  |  |
|  |  \--- PI + - SD
|  |         4h33 PI + - SD VM2 UiT.csv
|  |         24h33 PI + - SD VM2 UiT.csv
|  |         168h33 PI + - SD VM2 UiT.csv
|  |         4h10 PI + - SD VM2 UiT.csv
|  |         24h10 PI + - SD VM2 UiT.csv
|  |         168h10 PI + - SD VM2 UiT.csv
|  |
|  \---Temporal changes
|         Temporal changes UiT.csv
|
+---Statistical analyses
|      Statistical analyses.csv
|
+---Supplementary material
|      Growth curve VM2 UiT.csv
|      Sea ice profiles Svalbard.csv
|      Dead diatoms 33 vs 10 UiT.csv
|
+---READfile.pdf
|
```

Description of each data file in the zip folder "Forgereau_2023":

In Svalbard Field > Environmental data

1) **Chl a Svalbard.csv**

This csv file mainly provides chlorophyll *a* (Chl *a*) values collected by the PHOTA Team, in April 2021, in Svalbard, either at Tempelfjorden (TF1 site), or at Van Mijenfjorden (VM1 and VM2 sites) from the ice-ocean interface (10 cm), 3 cm pooled cores, segments of ice cores (0-3 cm (bottom-ice) up to 40-53 cm (sea ice surface)) to obtain Chl *a* profiles for sea ice at Van Mijenfjorden (VM1 and VM2 sites), as well as from HPLC pooled cores (used by Janina E. Osanen, member of the PHOTA team, in her own MSc project at UiT The Arctic University of Norway for HPLC). These Chl *a* values were calculated from equation (1) (Parsons et al., 1984) (see below paragraph) for the water column as well as for sea ice before dilution correction, and from equation (2) (see below the paragraph) after sea ice dilution correction. This file also includes all factors used to calculate Chl *a* values: **i)** the factors used for the calibration (Fd in µg mL^{-1} and µg L^{-1}, and Tau) of the Turner Trilogy fluorometer, **ii)** the volumes of water filtered (in mL and L) prior to Chl *a* extraction, **iii)** the blank expressed in raw fluorescence unit (RFU) on the Turner Trilogy fluorometer, **iv)** the raw fluorescence measurements (in RFU) directly measured on the fluorometer and the blank corrected measurements, which were obtained before acidification (Rb) and after acidification (Ra) with HCl, after Chl *a* extraction (minimum 24 h extraction in 10 mL of 90% acetone). The numbers of cores which were pooled and melted together are indicated as well as the volume of filtered seawater (FSW) added to the pooled cores sections, and the volume total of melted sea ice and added FSW (mL). The Chl *a* (µg L^{-1}) values within the column Chl *a* (avg) (µg L^{-1}) – WATER

COLUMN in this csv file were used in **Table 1** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication, for the ice-ocean interface water, the bottom-ice (3 cm), and the pooled ice cores (3 cm) without added FSW. Equation (1) was used to calculate these values (see below paragraph). The Chl *a* (mg m^{-2}) values within the column Chl *a* (avg) (mg m^{-2}) – SEA ICE DILUTION CORRECTED in this csv file were also used in **Table 1** for the bottom-ice (3 cm), and the pooled ice cores (3 cm) without added FSW. Equation (2) was used to calculate these values (see below paragraph). The table at the bottom of this csv file provides the respective standard deviation (SD) of the average (n = 2) Chl *a* values which were obtained from the water column (in µg L^{-1}) and from the sea ice corrected for dilution (in mg m^{-2}), respectively. The duplicates are numbered 1 and 2, respectively, the average Chl *a* (n = 2) is noted avg.

Equation (1) (Parsons et al., 1984):

$$\text{Chl } a \text{ (µg L}^{-1}\text{)} = (((Fd \times Tau) \times (Rb - Ra)) \times (V_E / V_f)) \qquad (1)$$

Where:

Chl *a* (µg L^{-1}) = Chlorophyll *a* representative of algal biomass in sea ice, 3 cm melted pooled bottom-ice core sections, or ice-ocean interface water

- Parameters from calibration

Fd (µg mL^{-1}) = 1/slope of the calibration

Tau = Rb/Ra

- Parameters from samples

Rb (RFU) = Raw fluorescence before acidification

Ra (RFU) = Raw fluorescence after acidification

V_E (mL) = Volume extraction liquid (i.e., 90% acetone 10 mL)

V_f (L) = Volume filtered (Chl a-vol)

Equation (2):

$$\text{Chl } a \text{ (mg m}^{-2}\text{)} = \frac{\text{Equation (1) x Volume total dilution /1 000 000}}{(\pi \times 0.045^2 \times \text{number of pooled cores})} \qquad (2)$$

Where:

Chl *a* (mg m^{-2}) = Chlorophyll *a* representative of algal biomass in 3 cm melted pooled bottom-ice core sections or in sea ice sections (from 0-3 cm to 40-53 cm) of ice core profiles

Volume total dilution (mL) = Volume of melted sea ice (mL) and volume of added FSW (mL)

Number of pooled cores = number of 3 cm bottom-ice core sections that were pooled and melted together to obtain Chl *a* measurements

2) DIC Svalbard.csv

This csv file provides dissolved inorganic carbon (DIC) data from 3 cm melted pooled ice cores (i.e., diluted melt water via FSW addition) and from sea ice collected *in situ* (i.e., only water from melted ice segments), which were collected by the PHOTA Team, in April 2021, in Svalbard, at Tempelfjorden (TF1 site) and at Van Mijenfjorden (VM1 and VM2 sites). The average (n = 2) DIC in µmol kg^{-1} and respective standard deviation (SD), obtained from melted pooled ice cores (see first table at the top) and sea ice collected *in situ* (see second table at the bottom), were used in **Table 1** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. Besides, the average (n = 2) DIC in µmol L^{-1} from melted pooled ice cores (see first table at the top) were used to calculate primary productivity measurements (see the three files "TF1, VM1 and VM2 PI Svalbard.csv").

3) General Svalbard.csv

This csv file provides general sea ice characteristics (i.e., snow depth, sea ice thickness, draft and freeboard), which were collected by the PHOTA Team, in April 2021, in Svalbard, at Tempelfjorden (TF1 site) and at Van Mijenfjorden (VM1 and VM2 sites) for each pooled core which were later melted together for obtaining other measurements such as primary productivity and Chl *a*. Snow depth, sea ice thickness, draft and freeboard were averaged for the numbers of pooled cores collected at each site (i.e., TF1 (n = 8), VM1 (n = 4) and VM2 (n = 5)) and are provided in cm. The rounded average values of these sea ice characteristics are presented in **Table 1** (except the draft) with their respective standard deviation (SD) (also presented in this file) in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

4) Salinity Svalbard.csv

This csv file provides a comparison of salinity measurements collected by the PHOTA Team, in April 2021, in Svalbard, at Tempelfjorden (TF1 site) and at Van Mijenfjorden (VM1 and VM2 sites). The salinity measurements include ice-ocean interface water salinity, 3 cm pooled cores salinity (core + filtered seawater (FSW)), and bulk-ice salinity of bottom-ice core sections (0-3 cm). Salinity values are presented in **Table 1** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

5) Temperature Svalbard.csv

This csv file provides a comparison of temperature measurements collected by the PHOTA Team, in April 2021, in Svalbard, at Tempelfjorden (TF1 site) and at Van Mijenfjorden (VM1 and VM2 sites). The temperature measurements include ice-ocean interface water temperature collected using a Castaway®-CTD, and bottom-ice core temperature collected using a thermometer probe (RS PRO RS 1720) in drilled hole within the bottom-ice (0-3 cm). These values are presented in Celsius (ºC). Temperature values for the ice-ocean interface are presented in **Table 1** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

6) Bulk nutrients Svalbard.csv

This csv file provides bulk-ice inorganic nutrients (NO_2 + NO_3, $Si(OH)_4$ and PO_4) concentrations collected by the PHOTA Team, in April 2021, in Svalbard, at Tempelfjorden (TF1 site) and at Van Mijenfjorden (VM1 and VM2 sites), at the ice-ocean interface (within 10 cm) and in bottom-ice core sections (0-3 cm). These nutrients were then measured at UiT The Arctic University of Norway on a nutrient autoanalyzer (QuAAtro 39, SEAL Analytical, Germany). The nutrients were initially collected in pseudo-duplicates numbered 1 and 2, respectively, for the ice-ocean interface water and bottom-ice core sections, and are presented in the first table (top) of this file. The average (n = 2) of inorganic nutrients (NO_2 + NO_3, $Si(OH)_4$ and PO_4) are shown in the second table of this csv file. All nutrient values are presented in µmol L^{-1}. This file also includes the molar ratios of NO_2 + NO_3 to PO_4 (N:P) and NO_2 + NO_3 to $Si(OH)_4$ (N:Si) in the last table (bottom), which were calculated from the nutrient concentrations (in µmol L^{-1}) for the ice-ocean interface and bulk-ice. Inorganic nutrient values are presented in **Table 1** with their respective standard deviation (SD) (also presented in this file in the third table), in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

7) Brine nutrients Svalbard.csv

This csv file provides *in situ* brine inorganic nutrients (NO_2 + NO_3, $Si(OH)_4$ and PO_4) concentrations obtained by the PHOTA Team, in April 2021, in Svalbard, at Tempelfjorden (TF1 site) and at Van Mijenfjorden (VM1 and VM2 sites). *In situ* brine inorganic nutrients were calculated by first calculating brine salinity (S_b) using the equation (3) (Assur, 1960) (see below paragraph), and then by multiplying the bulk-ice nutrient concentrations with the ratio of brine salinity to bulk-ice salinity. These ratios are presented in the first table (top) of this file. Pseudo-duplicates of brine inorganic nutrients numbered 1 and 2, respectively, are shown in the second table of this file. The average (n = 2) of brine inorganic nutrients (NO_2 + NO_3, $Si(OH)_4$ and PO_4) are shown in the third table of this file. All nutrient values are presented in µmol L^{-1}. Molar ratios of NO_2 + NO_3 to PO_4 (N:P) and NO_2 + NO_3 to $Si(OH)_4$ (N:Si) were also calculated for the brine and are shown in the last table (bottom) of this file. Brine molar ratios N:P and N:Si, as well as brine inorganic nutrient values with their respective standard deviation (SD) (also presented in this file in the fourth table) are presented in **Table 1**, in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

Equation (3) (Assur, 1960):

$$S_b = \frac{1000}{(1 - 54.11/T_{ice})} \quad (3)$$

Where:

S_b = Brine salinity on the practical salinity scale (dimensionless)

T_{ice} (ºC) = Bulk-ice temperature > -8.2 ºC

8) Bulk POC/N Svalbard.csv

This csv file provides POC/N concentrations (in mg m^{-2}) in the bulk-ice and for pooled cores, and POC:PON molar ratios calculated from the bulk-ice POC/N concentrations, which were obtained by the PHOTA Team, in April 2021, in Svalbard, at Tempelfjorden (TF1 site) and at Van Mijenfjorden (VM1 and VM2 sites). The POC/N concentrations were measured at UiT

The Arctic University of Norway on a Lab-Leeman CEC 440 CHN Analyzer. The POC/N concentrations for 3 cm pooled cores are presented in the first table (top) of this file. Other columns of the first table (top) of this file are parameters which were used to measure the POC/N concentrations in mg m^{-2} for pooled cores. POC concentrations for the bulk-ice (i.e., bottom-ice) are shown in the second table and PON concentrations for the bulk-ice are shown in the third table of this file. These bulk-ice POC/N concentrations were calculated from POC/N concentrations in melted ice (in mg m^{-2}), melted ice density and sea ice density. POC:PON molar ratios were calculated from POC:PON weight ratios and these ratios are presented at the bottom of this csv file. POC/N concentrations (in mg m^{-2}) in the bulk-ice and for pooled cores, and bulk-ice POC:PON molar ratios are presented in **Table 1**, in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

9) Brine POC/N Svalbard.csv

This csv file provides POC/N concentrations (in mg m^{-2}) in the brine, and POC:PON molar ratios calculated from the brine POC/N concentrations, which were obtained by the PHOTA Team, in April 2021, in Svalbard, at Tempelfjorden (TF1 site) and at Van Mijenfjorden (VM1 and VM2 sites). Brine POC and PON concentrations were calculated from bulk-ice POC and PON concentrations presented in the second table of this file, which were multiplied by the brine to bulk-ice ratio shown in the first table (top) of this file. Brine POC:PON molar ratios were calculated from brine POC:PON weight ratios and these ratios are presented at the bottom of this csv file. POC/N concentrations (in mg m^{-2}) in the brine, and brine POC:PON molar ratios are presented in **Table 1**, in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

In Svalbard Field > Community composition

1) TF1 composition Svalbard.csv

This csv file provides the community composition of pooled bottom-ice core sections (3 cm) which were collected at TF1 (Tempelfjorden site) on 12 April, 2021, by the PHOTA team. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø using an inverted microscope. The three factors (F1, F2, F3) were calculated using equations (4), (5) and (6), respectively (see below the paragraph). The cell abundance (cells/L) was calculated based on the sum of cells counted over all transects and with the three factors F1, F2 and F3, using equation (7) (see below the paragraph). The total number of alive cells after correction with the three factors, and the total number of cells directly counted over transects are provided at the bottom of this csv file. Cells were all counted as function of their taxonomy and size. Dead cells (i.e., empty frustules) were also counted but were not included within the total number of alive cells. Specific values to the TF1 sample are provided here: the volume of sedimented sample was 10 mL, the transect length was 20 mm, the number of counted transects was 4, the volume total dilution (sea ice cores + FSW) was 6027 mL, and the volume of sea ice was 1527 mL. The number of cells counted on the 4 transects are given in the columns T1, T2, T3 and T4. Some pennate diatoms were identified (*Cylindrotheca closterium*, *Entomoneis* spp., *Pleurosigma-gyrosigma* spp., *Nitzschia frigida*, *Nitzschia* spp., *Navicula* spp.), while some other pennate diatoms and flagellates were unidentified.

Equations (4), (5), (6) and (7):

$$F1 = 1000 / \text{volume sedimented sample} \quad (4)$$

$$F2 = (590.93 / (0.545 \times \text{transect length} \times \text{Nb transects})) \quad (5)$$

$$F3 = \text{Volume total dilution} / \text{Volume sea ice} \quad (6)$$

$$\text{Cell abundance} = (T1 + T2 + T3 + T4) \times F1 \times F2 \times F3 \quad (7)$$

Where:

F1 (mL) = Volume factor

Volume sedimented sample (mL) = volume of sample that sedimented prior to counting

F2 = Microscope factor

Transect length (mm) = 20 mm. Length on which ice algal cells were counted over each transect.

Nb transects = number of counted transects to reach a minimum of 400 cells

F3 (mL) = Dilution factor

Volume total dilution (mL) = Volume of melted sea ice (mL) and volume of added FSW (mL)

Cell abundance (cells/L) = number of cells per litre

T1, T2, T3, T4 = 4 transects over which cells were counted

2) VM1 composition Svalbard.csv

This csv file provides the community composition of pooled bottom-ice core sections (3 cm) which were collected at VM1 (Van Mijenfjorden site 1) on 17 April, 2021, by the PHOTA team. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø, using an inverted microscope. The structure and all calculations of this csv file are similar to what is in the description of the csv file "TF1 composition Svalbard.csv". Specific values to the VM1 sample are provided here: the volume of sedimented sample was 0.8 mL, the transect length was 20 mm, the number of counted transects was 4, the volume total dilution (sea ice cores + FSW) was 2980 mL, and the volume of sea ice was 700 mL. The number of cells counted on the 4 transects are given in the columns T1, T2, T3 and T4. Some pennate diatoms were identified (*Cylindrotheca closterium*, *Entomoneis* spp., *Pleurosigma-gyrosigma* spp., *Nitzschia frigida*, *Nitzschia* spp., *Navicula* spp.), while some other pennate diatoms and flagellates were unidentified.

3) VM2 composition Svalbard.csv

This csv file provides the community composition of pooled bottom-ice core sections (3 cm) which were collected at VM2 (Van Mijenfjorden site 2) on 14 April, 2021, by the PHOTA team. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø, using an inverted microscope. The structure and all calculations of this csv file are similar to what is in the description of the csv file "TF1 composition Svalbard.csv". Specific values to the VM2 sample are provided here: the volume of sedimented sample was 10 mL, the transect length was 20 mm, the number of counted transects was 3, the volume total dilution (sea ice cores + FSW) was 3580 mL, and the volume of sea ice was 780 mL. The number of cells counted on the 3 transects are given in the columns T1, T2, and T3. Some pennate diatoms were identified (*Cylindrotheca closterium*, *Entomoneis* spp., *Pleurosigma-*

gyrosigma spp., *Nitzschia frigida*, *Nitzschia* spp., *Navicula* spp.), while some other pennate diatoms and flagellates were unidentified.

4) Composition 3 sites Svalbard.csv

This csv file provides a comparison of the cell abundance (i.e., total of alive cells) expressed in cells/L, relative community composition expressed in %, as well as dead pennate diatoms (i.e., empty frustules) expressed in cells/L and %, between the three sites TF1 (Tempelfjorden site), VM1 and VM2 (Van Mijenfjorden site 1 and 2, respectively). The total of alive cells comes from the three following csv files: 1) "TF1 composition Svalbard.csv", 2) "VM1 composition Svalbard.csv", 3) "VM2 composition Svalbard.csv". The relative community composition was calculated from equation (8) (see below paragraph) and these data were used in **Figure 3**, in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The dead pennate diatoms were calculated from equation (9) (see below paragraph).

Equations (8) and (9):

$$\text{Relative community composition} = (\text{Nb cells}_j / \text{Nb cells}_{total}) \times 100 \quad (8)$$

Where:

Relative community composition (%)

Nb $cells_j$ (cells/L) = number of alive cells per litre for one type of sea ice algal cells (j)

Nb $cells_{total}$ (cells/L) = total number of alive cells counted per litre for all types of sea ice algal cells

$$\text{dead pennate 1} = (\text{dead pennate 2} / \text{Nb}_{total}\ \text{alive,dead cells}) \times 100 \quad (9)$$

Where:

dead pennate 1 (%) = relative abundance of dead pennate diatoms (i.e., empty frustules)

dead pennate 2 (cells/L) = number of dead pennate diatoms (i.e., empty frustules) per litre

Nb_{total} alive,dead cells (cells/L) = Total number of alive and dead pennate diatoms per litre in a sample

In Svalbard Field > PI curves field

1) TF1 PI Svalbard.csv

This csv file provides data used to build the photosynthesis-irradiance (PI) curve of the bottom-ice algal community collected at TF1 (Tempelfjorden site) which is shown in **Figure 4A** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. These data include irradiance and Chl *a*-normalized gross primary productivity (GPP). Irradiance (light intensity/integrated PAR) was measured from a light probe (Walz US-SQS/L) in triplicate, in each flask placed within the light chamber at different distances from a LED light source. The averaged values (n = 3) of irradiance are

shown in this csv file. GPP data expressed in µg C L^{-1} h^{-1}, referred to as productivity in this file, were obtained after a 3 h ^{14}C-incubation and were calculated using equation (10) (Søgaard et al., 2010) (see below paragraph). Chl *a*-normalized GPP expressed in µg C µg Chl a^{-1} h^{-1} was measured from GPP data using the equation (11) (see below paragraph). The photophysiological (PI) parameters P_{max}, alpha (i.e., α^B), beta (i.e., β^B) and I_k are shown in a table at the bottom of this csv file. These data were obtained from a Matlab code which was written to model PI parameters and PI curves from irradiance and Chl *a*-normalized GPP data measured experimentally. The exponential model from Platt et al. (1981), see equation (12) (see below paragraph) was used to plot the PI curve of the TF1 bottom-ice algal community in **Figure 4A** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening". The line in the PI curve represents the values from this exponential model using the modelled PI parameters (i.e., Pmax, alpha and beta in this file) while the dots represent the Chl *a*-normalized GPP data measured experimentally. The respiration in darkness (R) was not included in this model which is why it is equal to 0 in this csv file.

Equation (10) (Søgaard et al., 2010):

$$GPP = \frac{\left((DPM_z - DPM_{average\ in\ darkness}) \times DIC \times F_{Disc} \times Molar\ Mass\ of\ Carbon\right)}{(Specific\ activity \times incubation\ time)} \qquad (10)$$

Where:

DPM_z = disintegrations per minute for each flask exposed to different irradiances (z) depending on the distance from the LED light source. This is a measure of radioactivity. These DPM data were collected from radioactive samples analysed on a scintillation counter in a scintillation cocktail (ecolume).

$DPM_{average\ in\ darkness}$ = average (*n* = 2) DPM values from flasks exposed to darkness.

DIC (µmol L^{-1}) = average (*n* = 2) DIC data which were measured from 3 cm pooled bottom-ice core sections collected at TF1. These data come from the csv file "DIC Svalbard.csv".

F_{Disc} = a constant of 1.05 (discrimination factor for algal assimilation of $^{12}CO_2$ over $^{14}CO_2$)

Molar Mass of Carbon (g mol^{-1}) = 12.01 g mol^{-1}

Specific activity (DPM mL^{-1}) = DPM value in the T0 treatment at the start of the experiment (to measure the initial radioactivity of the sample) multiplied by 1220

Incubation time (h) = 3 hours. The time at which the samples were placed in the light chamber and were taken out of the chamber are indicated in the table on the right of the file.

Equation (11):

$$\text{Chl } a\text{-normalized GPP} = GPP / \text{Chl } a \qquad (11)$$

Where:

Chl *a*-normalized GPP (µg C µg Chl a^{-1} h^{-1}) = Chl *a*-normalized gross primary productivity values

Chl *a* (µg L^{-1}) = average Chl *a* (*n* = 2) values from 3 cm pooled bottom-ice core sections used to obtain GPP at TF1. The Chl *a* value comes from the csv file "Chl a Svalbard.csv".

Equation (12) exponential model (Platt et al., 1981):

$$GPP = P_{max} (1- e^{\frac{-\alpha^B I_z}{P_{max}}}) e^{\frac{-\beta^B I_z}{P_{max}}} \qquad (12)$$

Where:

GPP (µg C µg Chl a^{-1} h^{-1}) = Chl *a*-normalized gross primary productivity

P_{max} (µg C µg Chl a^{-1} h^{-1}) = Maximum photosynthetic rate

α^B (µg C µg Chl a^{-1} h^{-1} [µmol photons m^{-2} s^{-1}]$^{-1}$) = Photosynthetic efficiency

β^B (µg C µg Chl a^{-1} h^{-1} [µmol photons m^{-2} s^{-1}]$^{-1}$) = Photoinhibition rate

I_z (µmol photons m^{-2} s^{-1}) = Irradiance of each flask (z) depending on the distance from the LED light source

2) VM1 PI Svalbard.csv

This csv file provides data used to build the photosynthesis-irradiance (PI) curve of the bottom-ice algal community collected at VM1 (Van Mijenfjorden site 1) which is shown in **Figure 4B** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The structure and all calculations of this csv file are similar to what is in the description of the csv file "TF1 PI Svalbard.csv".

3) VM2 PI Svalbard.csv

This csv file provides data used to build the photosynthesis-irradiance (PI) curve of the bottom-ice algal community collected at VM2 (Van Mijenfjorden site 2) which is shown in **Figure 4C** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The structure and all calculations of this csv file are similar to what is in the description of the file "TF1 PI Svalbard.csv".

UiT Laboratory > Chl a

1) Chl a 10 UiT.csv

This csv file provides Chl *a* data of a VM2 cultured ice algal community after 4, 24 and 168 h growth in a lowered salinity treatment of 10, and at initial start of the experiment (0 h). These data were collected by Zoé Forgereau at UiT The Arctic University of Norway in October-December 2021. The structure and all calculations of this csv file are similar to what is in the description of the csv file "Chl a Svalbard.csv", including the use of equation (1) (Parsons et al., 1984) to calculate Chl *a* in µg L^{-1}, except that Fd is here in µg L^{-1} and V_f in mL. However, in this csv file, the Chl *a* data correspond to temporal changes in the algal biomass of a VM2 cultured ice algal community growing in culturing flasks at different time points (0, 4, 24 and 168 h), so no sea ice was melted during the lab-based experiments, and therefore the Chl *a* values were not converted into mg m^{-2}. The values in the column "average of duplicates" were

used in the csv files “PI VM2 4h10, 24h10 and 168h10 UiT.csv”, to obtain Chl *a*-normalized GPP measurements. These Chl *a* values were used in the csv file “Chl a 33 vs 10 UiT.csv”, to plot **Figure 5** in the manuscript “Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. Besides, the time points which were rerun for A (due to the lack of data consistency) are shown in the table at the bottom of this csv file.

2) Chl a 33 UiT.csv

This csv file provides Chl *a* data of a VM2 cultured ice algal community after 4, 24 and 168 h growth in a control salinity treatment of 33, and at initial start of the experiment (0 h). These data were collected by Zoé Forgereau at UiT The Arctic University of Norway in October-December 2021. The structure and all calculations of this csv file are very similar to what is in the description of the csv file “Chl a 10 UiT.csv”, except that the salinity is 33, and that the Chl *a* values in the column “average of duplicates” were used in the csv files “PI VM2 4h33, 24h33 and 168h33 UiT.csv”, to obtain Chl *a*-normalized GPP measurements.

3) Chl a 33 vs 10 UiT.csv

This csv file provides a comparison of Chl *a* values of a VM2 cultured ice algal community in two salinity treatments (control salinity of 33 in the top table, versus lowered salinity of 10 in the bottom table) at four time points (0 h, 4 h, 24 h, 168 h) and in the triplicate (A, B, C). For each time point, the average (n = 3 or n = 4) Chl *a* values, the respective standard deviation (SD) as well as plus (+) and minus (-) SD are shown. These average and SD values were used to plot **Figure 5** in the manuscript “Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. Some time points were rerun since the results of photophysiology, and primary productivity were not consistent, which is why there is a column “rerun A”, and also why four values were averaged at the time point 0 h see **Figure 5** in the manuscript “Photophysiological responses of Arctic bottom sea-ice algae to freshening".

In UiT Laboratory > Cell abundance

1) VM2 composition 4h10 UiT.csv

This csv file provides the composition of the VM2 lab-based cultured ice algal community after 4 h growth in a lowered salinity treatment of 10. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø using an inverted microscope. The two factors (F1, F2) were calculated using equation (4) and (5), respectively, see description of the csv file “TF1 composition Svalbard.csv”, which then used to calculate the cell abundance (cells/L). In this csv file, F3 was not used since it is a dilution factor that is only used for diluted sea ice samples with FSW, and here, sea ice algae were growing in culturing flasks in the laboratory. The cells were counted in triplicate (A, B, C) on different dates (10th December, 3rd November, and 11th December 2021, respectively). The volumes of sedimented samples were 0.37, 0.245 and 0.33 mL for A, B and C, respectively. The transect length was 20 mm and the number of counted transects was 3 for the triplicate. The number of cells counted on the 3 transects are given in the columns T1, T2, and T3. Several pennate diatoms and flagellates were counted as alive cells. One pennate diatom *Synedropsis hyperborea* dominated the community. The cell abundance (cells/L) was calculated based on equation (7) see description of the csv file “TF1 composition Svalbard.csv”, except that the cells were

counted on three transects (T1, T2 and T3) and F3 was not used (=0). The total number of alive cells after correction with the two factors, and the total number of cells directly counted over transects are provided at the bottom of each table. Cells were all counted as function of their taxonomy and size. Dead pennate diatom cells (i.e., empty frustules) were also counted but were not included within the total number of alive cells.

2) VM2 composition 24h10 UiT.csv

This csv file provides the composition of the VM2 lab-based cultured ice algal community after 24 h growth in a lowered salinity treatment of 10. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø using an inverted microscope. The structure and all calculations of this csv file are similar to what is in the description of the csv file "VM2 composition 4h10 UiT.csv". Specific values for this csv file are: **i)** the collection dates for the triplicate A, B and C which are 10th December, 19th November, and 2nd December 2021, respectively, and **ii)** the volumes of sedimented samples were 0.535, 0.245 and 0.385 mL for A, B and C, respectively.

3) VM2 composition 168h10 UiT.csv

This csv file provides the composition of the VM2 lab-based cultured ice algal community after 168 h growth in a lowered salinity treatment of 10. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø using an inverted microscope. The structure and all calculations of this csv file are similar to what is in the description of the csv file "VM2 composition 4h10 UiT.csv". Specific values for this csv file are: **i)** the collection dates for the triplicate A, B and C which are 6th December, 3rd December, and 5th December 2021, respectively, and **ii)** the volumes of sedimented samples were 0.125, 0.115 and 0.165 mL for A, B and C, respectively.

4) VM2 composition 4h33 UiT.csv

This csv file provides the composition of the VM2 lab-based cultured ice algal community after 4 h growth in a control salinity treatment of 33. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø using an inverted microscope. The structure and all calculations of this csv file are similar to what is in the description of the csv file "VM2 composition 4h10 UiT.csv", except that the salinity is 33. Specific values for this csv file are: **i)** the collection dates for the triplicate A, B and C which are 7th December, 19th November, and 29th November 2021, respectively, and **ii)** the volumes of sedimented samples were 0.57, 0.53 and 0.41 mL for A, B and C, respectively.

5) VM2 composition 24h33 UiT.csv

This csv file provides the composition of the VM2 lab-based cultured ice algal community after 24 h growth in a control salinity treatment of 33. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø using an inverted microscope. The structure and all calculations of this csv file are similar to what is in the description of the csv file "VM2 composition 4h10 UiT.csv", except that the salinity is 33. Specific values for this csv file are: **i)** the collection dates for the triplicate A, B and C which are 4th December, 4th December, and 2nd December 2021, respectively, and **ii)** the volumes of sedimented samples were 0.435, 0.23 and 0.22 mL for A, B and C, respectively.

6) **VM2 composition 168h33 UiT.csv**

This csv file provides the composition of the VM2 lab-based cultured ice algal community after 168 h growth in a control salinity treatment of 33. Cell identification was conducted by Zoé Forgereau at UiT The Arctic University of Norway in Tromsø using an inverted microscope. The structure and all calculations of this csv file are similar to what is in the description of the csv file "VM2 composition 4h10 UiT.csv", except that the salinity is 33. Specific values for this csv file are: **i)** the collection dates for the triplicate A, B and C which are 11th December, 3rd December, and 5th December 2021, respectively, and **ii)** the volumes of sedimented samples were 0.045, 0.023 and 0.03 mL for A, B and C, respectively.

7) **VM2 abundance 33 vs 10 UiT.csv**

This csv file provides a comparison of the relative community composition in %, and the cell abundance in cells/L between two salinity treatments (control salinity of 33 and lowered salinity of 10). The relative community composition (%) of pennate diatoms and flagellates was averaged from the triplicate (A, B, C) values after 4 , 24 and 168 h growth in each salinity treatment. Respective standard deviations (SD) of these averages are also provided in this csv file. Besides, the values of the cell abundance (cells/L) are shown for each triplicate after 4, 24 and 168 h growth in each salinity treatment. The averaged values of the relative community composition (%) with respective standard deviations, as well as the algal cell abundance (cells/L) data from triplicates were used in **Figure 6**, in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

In UiT Laboratory > PI curves UiT > PI curves 33 and 10

1) **PI VM2 4h33 UiT.csv**

This csv file provides data used to build the photosynthesis-irradiance (PI) curves (n = 3) of the VM2 cultured ice algal community after 4 h growth at salinity 33 which is shown in **Figure 7A** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The structure and all calculations of this csv file are similar to what is in the description of the csv file "TF1 PI Svalbard.csv", except that Chl *a* values come from culturing flasks from the csv file "Chl a 33 UiT.csv", also that this csv file provides a triplicate (A, B and C) for the VM2 lab-cultured ice algal community and that the exponential term including β^B is removed from equation (12) since the algae were not photoinhibited ($\beta^B = 0$). In **Figure 7A** in the submitted manuscript, the black solid line in the PI curve represents the average (n = 3) of the three PI curves from this csv file whose data were obtained using the exponential model and the modelled PI parameters (Pmax and alpha in this file).

2) **PI VM2 24h33 UiT.csv**

This csv file provides data used to build the photosynthesis-irradiance (PI) curves (n = 3) of the VM2 cultured ice algal community after 24 h growth at salinity 33 which is shown in **Figure 7C** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The structure and all calculations of this csv file are similar to what is in the description of the csv file "PI VM2 4h33 UiT.csv".

3) **PI VM2 168h33 UiT.csv**

This csv file provides data used to build the photosynthesis-irradiance (PI) curves (n = 3) of the VM2 cultured ice algal community after 168 h growth at salinity 33 which is shown in **Figure 7E** in the manuscript “Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The structure and all calculations of this csv file are similar to what is in the description of the csv file “PI VM2 4h33 UiT.csv”.

4) **PI VM2 4h10 UiT.csv**

This csv file provides data used to build the photosynthesis-irradiance (PI) curves (n = 3) of the VM2 cultured ice algal community after 4 h growth at salinity 10 which is shown in **Figure 7B** in the manuscript “Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The structure and all calculations of this csv file are similar to what is in the description of the csv file “PI VM2 4h33 UiT.csv”, except that the salinity is 10, and that Chl *a* values come from the csv file “Chl a 10 UiT.csv”.

5) **PI VM2 24h10 UiT.csv**

This csv file provides data used to build the photosynthesis-irradiance (PI) curves (n = 3) of the VM2 cultured ice algal community after 24 h growth at salinity 10 which is shown in **Figure 7D** in the manuscript “Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The structure and all calculations of this csv file are similar to what is in the description of the csv file “PI VM2 4h33 UiT.csv”, except that the salinity is 10, and that Chl *a* values come from the csv file “Chl a 10 UiT.csv”.

6) **PI VM2 168h10 UiT.csv**

This csv file provides data used to build the photosynthesis-irradiance (PI) curves (n = 3) of the VM2 cultured ice algal community after 168 h growth at salinity 10 which is shown in **Figure 7F** in the manuscript “Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The structure and all calculations of this csv file are similar to what is in the description of the csv file “PI VM2 4h33 UiT.csv”, except that the salinity is 10, and that Chl *a* values come from the csv file “Chl a 10 UiT.csv”.

In UiT Laboratory > PI curves UiT > PI + - SD

1) **4h33 PI + - SD VM2 UiT.csv**

This csv file provides the average (n = 3) of the PI model/curve representative of the photophysiological responses of a VM2 cultured ice algal community after 4 h growth in a control salinity of 33, as well as respective standard deviations (SD), plus (+) and minus (-) SD. The average and SD of the photophysiological parameters α (α^B), Pmax (P_s^B), I_k, and the coefficient of determination R^2 are also shown in this csv file. These data were directly used to plot the PI curves, except for R^2, in **Figure 7A** in the manuscript “Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. In **Figure 7**, the black solid represents the average (n = 3) of the photophysiological responses, while the dashed lines represent the + and – SD.

2) **24h33 PI + - SD VM2 UiT.csv**

The description of this csv file is the same as the description of the csv file "4h33 PI + - SD VM2 UiT.csv", except that this file provides the photophysiological responses of a VM2 cultured ice algal community after 24 h growth at a control salinity of 33, and that the data from this file were used to plot the PI curves in **Figure 7C** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

3) **168h33 PI + - SD VM2 UiT.csv**

The description of this csv file is the same as the description of the csv file "4h33 PI + - SD VM2 UiT.csv", except that this file provides the photophysiological responses of a VM2 cultured ice algal community after 168 h growth at a control salinity of 33, and that the data from this file were used to plot the PI curves in **Figure 7E** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

4) **4h10 PI + - SD VM2 UiT.csv**

The description of this csv file is the same as the description of the csv file "4h33 PI + - SD VM2 UiT.csv", except that the salinity differs since it is here 10, and that the data from this file were used to plot the PI curves in **Figure 7B** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

5) **24h10 PI + - SD VM2 UiT.csv**

The description of this csv file is the same as the description of the csv file "4h33 PI + - SD VM2 UiT.csv", except that this file provides the photophysiological responses of a VM2 cultured ice algal community after 24 h growth at a lowered salinity of 10, and that the data from this file were used to plot the PI curves in **Figure 7D** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

6) **168h10 PI + - SD VM2 UiT.csv**

The description of this csv file is the same as the description of the csv file "4h33 PI + - SD VM2 UiT.csv", except that this file provides the photophysiological responses of a VM2 cultured ice algal community after 168 h growth at a lowered salinity of 10, and that the data from this file were used to plot the PI curves in **Figure 7F** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

In UiT Laboratory > Temporal changes

1) **Temporal changes UiT.csv**

This csv file provides the average (n = 3) photophysiological parameters P_s^B (µg C µg Chl a^{-1} h^{-1}), α^B (µg C µg Chl a^{-1} h^{-1} [µmol photons m^{-2} s^{-1}]$^{-1}$) and I_k (µmol photons m^{-2} s^{-1}) with their respective standard deviation (SD) of a VM2 cultured ice algal community after 4, 24 and 168 h growth in two salinity treatments (a control salinity of 33 versus a lowered salinity of 10). Therefore, this csv file shows the temporal changes in these three photophysiological

parameters over time in the two salinity treatments. These data were used in **Figure 7** and **Figure 8** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

In Statistical analyses

1) Statistical analyses.csv

This csv file provides the results of statistical analyses (Welch t-test, Independent t-test, One-way ANOVA, Kruskal Wallis H test, ANOVA - Fisher´s Post-hoc test of significance) for the laboratory-based data (photophysiological parameters (P_s^B, α^B and I_k), Chl *a*, relative abundance of flagellates to community composition, and cell abundance of cultured algae). These data are presented in **Table 2** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. Further description of these data is provided in **Section 2.3** "Statistical analyses" and into the table caption of **Table 2** in this submitted manuscript.

In Supplementary material

1) Growth curve VM2 UiT.csv

This csv file provides ln average (n = 5) of raw fluorescence (RFU-1 to 5) data over time (7 days – collected from 01/10/2021 to 07/10/2021 by Zoé Forgereau at UiT The Arctic University of Norway). These data were used to plot the growth curve of a VM2 cultured ice algal community in **Supplementary Figure 1** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication. The specific growth rate μ was also calculated from equation (13) (Zhang et al., 1999) (see below paragraph). The overall specific growth rate (μ_t) over 7 days was 0.36 d^{-1}. In this file, RFU stands for raw fluorescence unit, and FSW for filtered seawater.

Equation (13) (Zhang et al., 1999):

$$\mu t = \ln (Nt2 / Nt1) / (t2 - t1) \quad (13)$$

Where:

μt = Specific growth rate at a time t

N_{t2} = Algal biomass (Chl *a*) at time t2

N_{t1} = Algal biomass (Chl *a*) at time t1

t2 = Time t2 (after t1)

t1= Time t1 (before t2)

2) Sea ice profiles Svalbard.csv

This csv file provides data collected by the PHOTA team in April 2021, at Tempelfjorden (TF1 site) and Van Mijenfjorden (VM1 and VM2 sites) such as bulk-ice temperature (T_{ice}), bulk-ice salinity (S_{ice}), brine salinity (S_b), and brine volume fraction (V_b) as function of the sea ice depth

(cm). Bulk-ice temperature was measured using a thermometer probe (RS PRO RS 1720), and bulk-ice salinity using a conductivity meter (ProfiLine Cond 3110-WTW). Brine salinity and brine volume fraction were calculated using equation (3) (Assur, 1960) (see description of csv file "Brine nutrients Svalbard.csv") and equation (14) (Frankenstein and Garner, 1967) (see below), respectively. This csv file additionally provides Chl *a* data (mg m^{-2}) over sections (from bottom-ice (0-3 cm) to sea ice surface (40-53 cm)) of a sea ice core from VM1 and VM2. No specific Chl *a* core was collected at TF1. The Chl *a* data in this file come from the csv file "Chl a Svalbard.csv", where the calculation for sea ice dilution corrected values is provided (see equation (2)). Bulk-ice temperature, bulk-ice salinity, brine volume fraction and Chl *a* data as function of sea ice depth were used to plot sea ice profiles in **Supplementary Figure 2** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

Equation (14) (Frankenstein and Garner, 1967):

$$V_b = [S_{ice} \times (\frac{45.917}{|T_{ice}|} + 0.930)] / 10 \quad (14)$$

Where:

V_b (%) = Brine volume fraction

S_{ice} = Bulk-ice salinity on the practical salinity scale (dimensionless)

T_{ice} (ºC) = Bulk-ice temperature between -2.06 to -8.2 ºC

3) Dead diatoms 33 vs 10 UiT.csv

This csv file provides data of dead pennate diatoms (i.e., empty frustules) in the two salinity treatments (control salinity of 33 versus lowered salinity of 10) for each time point (4, 24, 168 h) for the triplicate (A, B, C). Relative abundance of dead pennate diatoms (%) data were obtained from the cell abundance of dead pennate diatoms (cells/L) over the total number of alive and dead cells of the VM2 cultured community (see equation (9) in csv file "Composition 3 sites Svalbard.csv"), and are given as percentages in this file. Values of cell abundance (cells/L) come from the csv files "VM2 composition 4h10, 24h10, 168h10 or 4h33, 24h33, 168h33 UiT.csv". The average (n = 3) relative abundance of dead pennate diatoms (%) data were used, with their respective standard deviations (SD), in **Supplementary Table 1** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

Further details of the methods can be found in **Section 2** in the manuscript "Photophysiological responses of Arctic bottom sea-ice algae to freshening" that has been submitted for publication.

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