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Supplement of

Photosynthetic production in the Central Arctic during the record sea-ice minimum in 2012

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Table S1. Datasets related to this publication stored in the Earth system science database PANGAEA.

Dataset	PANGAEA doi	Reference
Sea-ice conditions	doi:10.1594/PANGAEA.803221	(Fernández-Méndez et al., 2014)
Physical oceanography	doi:10.1594/PANGAEA.802904	(Hendricks et al., 2012)
Physical oceanography	doi:10.1594/PANGAEA.819452	(Rabe et al., 2012)
Net primary productivity	doi:10.1594/PANGAEA.834221	(Fernández-Méndez et al., 2014b)
Nutrients water column	doi:10.1594/PANGAEA.834081	(Rabe et al., 2012)
Nutrients sea ice	doi:10.1594/PANGAEA.834084	(Bakker, 2014)

Table S2. Comparison of three runs of the CAOPP model using the photosynthetic parameters measured in situ in summer 2012. Sea-ice extent, multiyear ice fraction, incoming irradiance and mean INPP in Tg C month^{-1} are presented for the month of September in 1982, 2012 and 2050. Since the purpose is a magnitude comparison between different scenarios in the different sectors of the Eurasian Basin, only the mean is shown. Min and Max values would deviate from the mean as presented in Table 4 for 2012.

	CAOPP results for September north of 78ºN			
	September ice extent	MYI fraction	Incoming irradiance	INPP September
	Mean	Mean	Mean (Min-Max)	Mean (Min-Max)
	Mio. Km^{-2}	%	µmol photons m-2 s-1	Tg C month^{-1}
	1982 (7.17 Mi. Km^{2})			
Eurasian Basin (78-90N, 45 W-135 E)	1.78	71	59 (28-122)	0.93
Laptev (78-90 N, 90-135 E)	0.53	92	54 (28-84)	0.26
Kara (78-90 N, 45-90 E)	0.50	85	59 (31-75)	0.27
Barents (78-90 N, 0-45 E)	0.44	88	64 (30-104)	0.26
Greenland (78-90 N, 45 W-0 E)	0.31	82	63 (29-122)	0.13
	2012 (3.42 Mio.km^{2})			
Eurasian Basin (78-90 N, 45 W-135 E)	1.01	51	45 (23-102)	1.88
Laptev (78-90 N, 90-135 E)	0.29	12	47 (24-84)	0.63
Kara (78-90 N, 45-90 E)	0.16	30	42 (25-76)	0.66
Barents (78-90 N, 0-45 E)	0.25	50	42 (25-69)	0.46
Greenland (78-90 N, 45 W-0 E)	0.30	77	52 (24-102)	0.13
	2050 (No ice) ¥			
Eurasian Basin (78-90N, 45 W-135 E)	0	0	45 (23-102)	2.91
Laptev (78-90 N, 90-135 E)	0	0	47 (24-84)	0.87
Kara (78-90 N, 45-90 E)	0	0	42 (25-76)	0.81
Barents (78-90 N, 0-45 E)	0	0	42 (25-69)	0.72
Greenland (78-90 N, 45 W-0 E)	0	0	52 (24-102)	0.51

Table S3. In situ rates of depth integrated net primary productivity in melt ponds, sea ice and water column at eight ice stations sampled during summer 2012. Sea-ice and metl pond productivity were integrated through their thickness and depth respectively, and water column was integrated for the euphotic zone (1% PAR). Ice thickness, melt pond depth and euphotic zone depth are described for each station in Table 1. Only PI curves with an R2>0.5 were used for the NPP calculations. The average error of the carbon uptake measurements was 15%.

	Integrated Net Primary Productivity *in situ* mg C m^{-2} d^{-1} (% Contribution to total)							
Station Number	1	2	3	4	5	6	7	8
Melt Pond	2 (4)	0.01 (0)	4 (24)	0.2 (2)	0.2 (0)	0.02 (0)	1 (34)	0.2 (26)
Sea Ice	13 (33)	1 (3)	0.8 (5)	0.4 (7)	0.1 (0)	0.2 (1)	1.5 (50)	0.5 (62)
Water under the ice	25 (63)	31 (97)	11 (71)	6 (91)	60 (100)	28 (99)	0.5 (16)	0.1 (12)
Total	40	32	16	7	60	29	3	0.8

Supplementary Figures

Figure S1. Average photosynthesis versus irradiance curves (PI curve) for each environment. The average fitted curve and the photosynthetic parameters derived it, were used to calculate the in situ primary production in each environment during August and September for the Eurasian Basin using the irradiance-based CAOPP model. The dots represent the experimental measurements, the black solid line is the fitted curve, the dashed lines are the minimum and the maximum, and the grey shaded area is the standard deviation. Average PI parameters are represented on the top left corner.

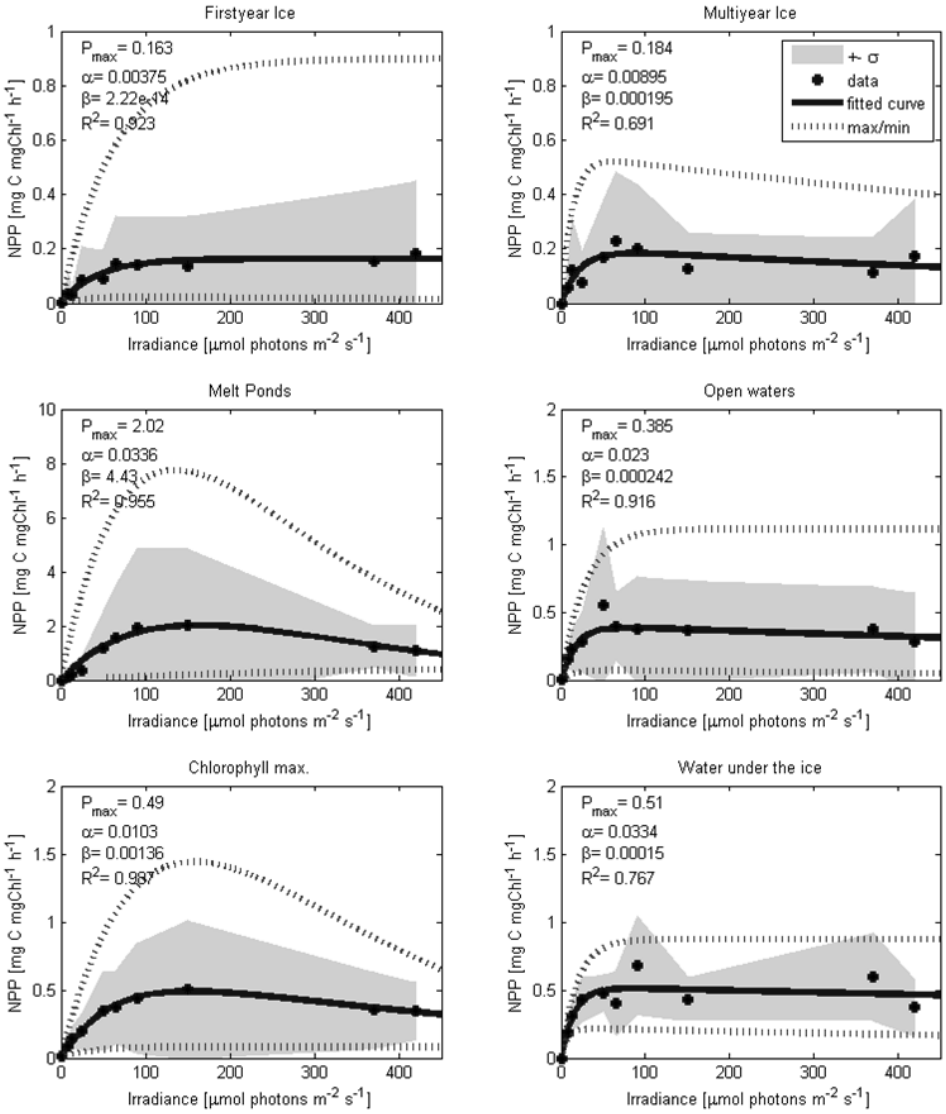

Firstyear Ice
P_{max}= 0.163
α= 0.00375
β= 2.22e-14
R^2= 0.923
Multiyear Ice
P_{max}= 0.184
α= 0.00895
β= 0.000195
R^2= 0.691
+- σ
data
fitted curve
max/min
Melt Ponds
P_{max}= 2.02
α= 0.0336
β= 4.43
R^2= 0.955
Open waters
P_{max}= 0.385
α= 0.023
β= 0.000242
R^2= 0.916
Chlorophyll max.
P_{max}= 0.49
α= 0.0103
β= 0.00136
R^2= 0.987
Water under the ice
P_{max}= 0.51
α= 0.0334
β= 0.00015
R^2= 0.767
NPP [mg C mgChl^{-1} h^{-1}]
Irradiance [μmol photons m^{-2} s^{-1}]

Figure S2. N:Si and N:P molar ratios in the euphotic zone of the water column during summer 2012. In panel A, the light blue-green range represents N:Si ratios optimal for diatom growth, red marks an excess of N, blue-purple represents depletion. In panel B, all values are below the N:P Redfield ratio of 16 indicating a general nitrate depletion with respect to phosphate.

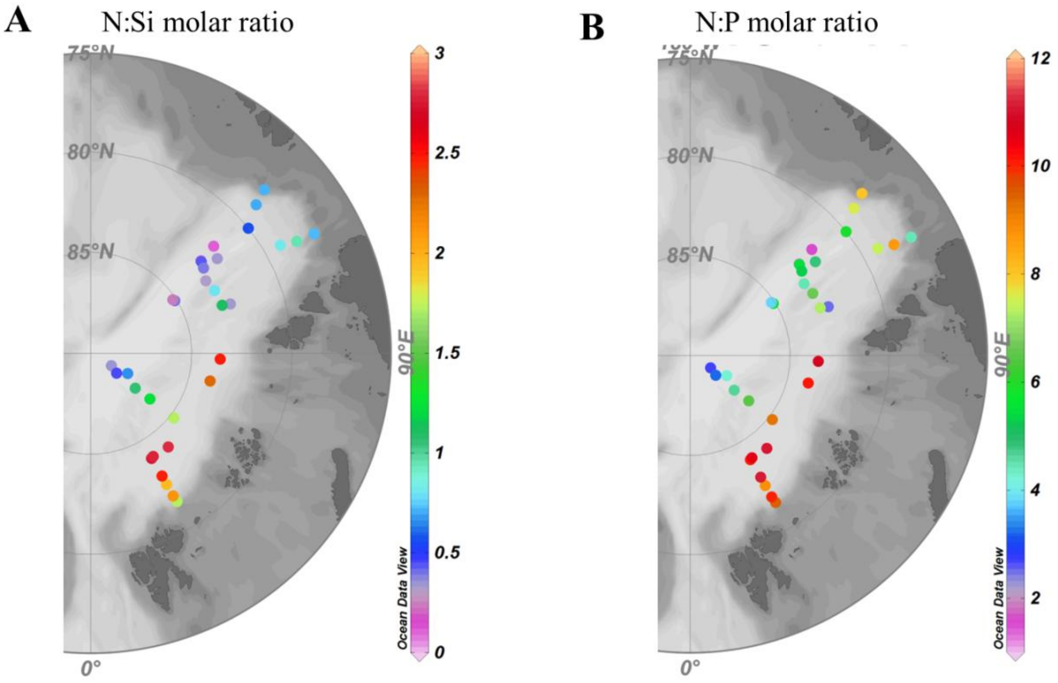
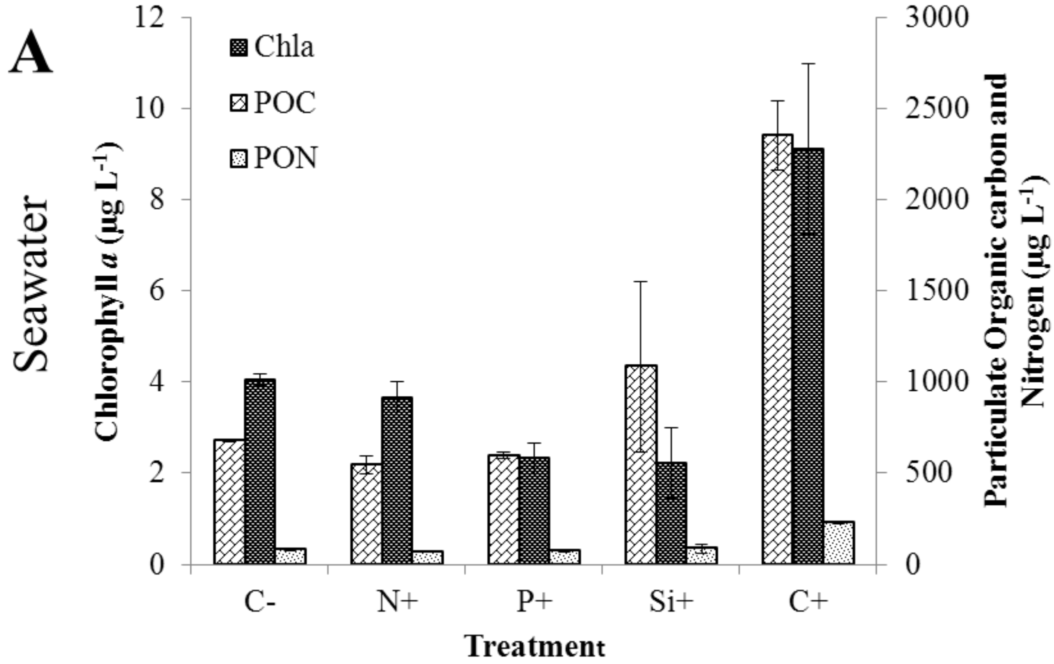


Figure S3. Biomass changes in nutrient addition experiments. (A) Nutrient addition experiment with seawater from the Chl *a* max depth at station 3. (B) Nutrient addition experiment with sea ice from station 8. Duplicates of each treatment were incubated for 2 days after nutrient addition.



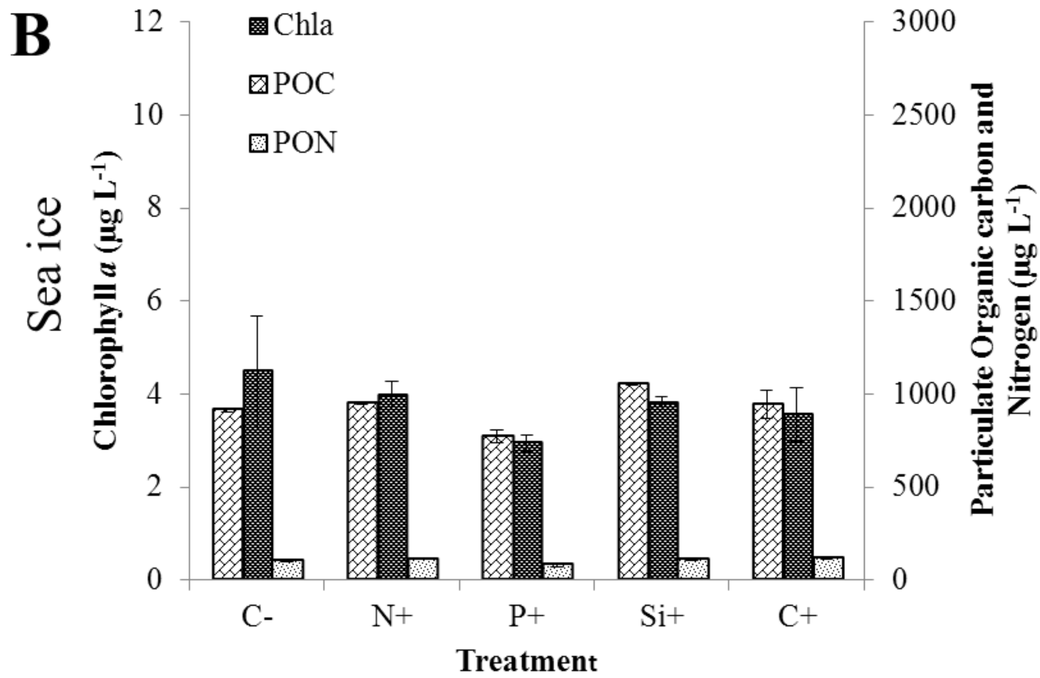


Figure S4. Microscopy images of the community composition of the two nutrient experiments: (A) sea water phytoplankton and (B) sea-ice algae.

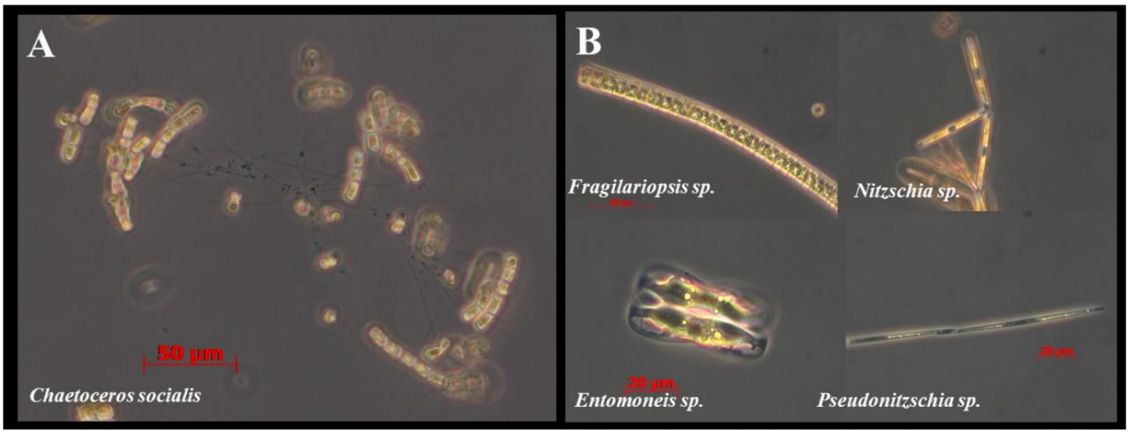


Figure S5. Euphotic zone depth (1% PAR) weighted average (A), and winter mixed layer depth (B) estimated from summer temperature profiles. Average and standard deviations: Euphotic zone depth 34 ± 6 m; Winter mixed layer depth 54 ± 15 m.

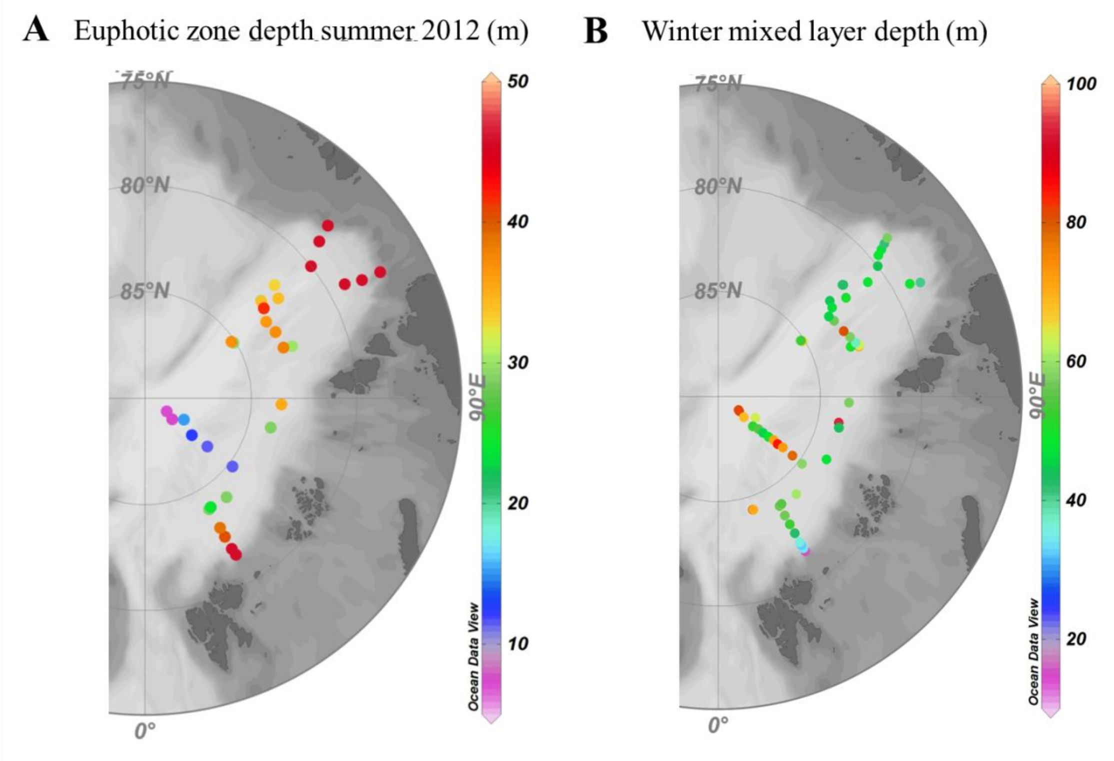


Figure S6. New production in the Eurasian Basin during 2012. Carbon uptake since last winter estimated from nitrogen (A), phosphate (B) and silicate (C) drawdown in the mixed layer. Redfield ratio C:N:Si:P of 106:16:15:1 was used to convert nutrient uptake into annual new production.

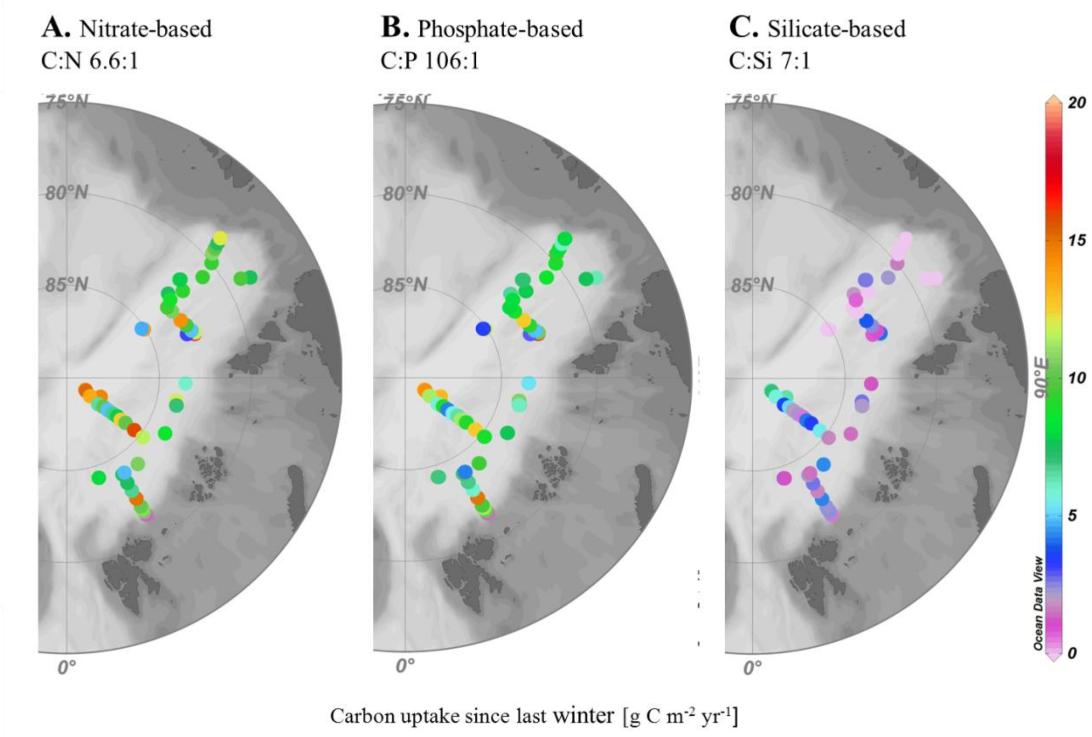


Figure S7. September mean total INPP for two runs of the CAOPP model under contrasting sea-ice conditions: (A) sea-ice cover and incoming irradiance as in 1982, (B) no-ice cover as predicted for 2050. Nutrient concentrations and photosynthetic parameters as in September 2012.

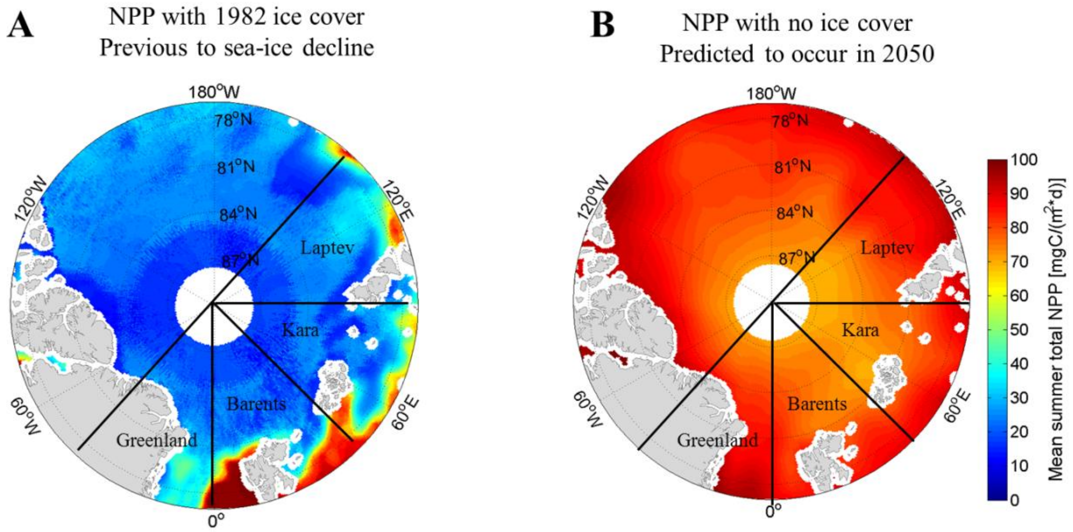


Figure S8. Fraction contribution of NPP in each environment (melt ponds, sea ice and water column) to total NPP in the Central Arctic during August and September 2012 according to the upscaling performed using the CAOPP model. The assumptions for key factors governing NPP are explained in the materials and method section.