Supplement for

New particle formation events observed at the King Sejong Station, Antarctic Peninsula – Part 2: Link with the oceanic biological activities

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Calculation of the sea surface DMSP concentration

We estimated the total dimethylsulfoniopropionate (DMSPt) concentration in the sea-surface using the algorithm developed by Galí et al. (2015). The DMSPt algorithm was implemented using the link between DMSPt and the chlorophyll concentration depending on the light exposure regime of the marine phytoplankton. The database was divided into three subsets including 'stratified water (Z_{eu}/MLD > 1)', 'mixed water (Z_{eu}/MLD < 1)' and 'undefined water (Z_{eu} or MLD is unavailable)' based on the ratio between the euphotic layer depth (Z_{eu}) and the mixed layer depth (MLD). The $DMSP_t$ concentrations in stratified, mixed and undefined water were calculated using Equations (S1), (S2) and (S3), respectively:

$$Log_{10}DMSP_t = 1.70 + 1.14log_{10}Chl_t + 0.44log_{10}Chl_t^2 + 0.063SST – 0.0024SST^2 \quad (S1)$$

$$Log_{10}DMSP_t = 1.74 + 0.81log_{10}Chl_t + 0.60log_{10}(Z_{eu}/MLD) \quad (S2)$$

$$log_{10}DMSP_t = -1.052 – 3.185log_{10}PIC – 0.783(log_{10}PIC)^2 \quad (S3)$$

The level-3 product of the Moderate Resolution Imaging Spectroradiometer on the Aqua (MODIS-Aqua) satellites was used for the chlorophyll concentration (Chl_t), sea surface temperature at nighttime (SST) and the calcite concentration (PIC). The monthly mixed layer depth (MLD) was retrieved by Monthly Isopycnal and Mixed-layer Ocean Climatology (MIMOC) at a resolution of 0.5° (Fig. S6). All of the MODIS-Aqua products at a resolution of 4 km were averaged onto a 0.5° interval grid of MIMOC climatology to run the DMSPt algorithm. The euphotic layer depth (Z_{eu}) was calculated using satellite-derived chlorophyll data as shown in Equation (S4) (Morel et al., 2007).

$$log_{10}Z_{eu} = 1.524 – 0.436log_{10}Chl_t – 0.0145(log_{10}Chl_t)^2 + 0.0186(log_{10}Chl_t)^3 \quad (S4)$$

References

Galí, M., Devred, E., Levasseur, M., Royer, S.-J., and Babin, M.: A remote sensing algorithm for planktonic dimethylsulfoniopropionate (DMSP) and an analysis of global patterns, Remote Sens. Environ., 171, 171–184, https://doi.org/10.1016/j.rse.2015.10.012, 2015.

Morel, A., Huot, Y., Gentili, B., Werdell, P. J., Hooker, S. B., and Franz, B. A.: Examining the consistency of products derive d from various ocean color sensors in open ocean (Case 1) waters in the perspective of a multi-sensor approach, Remote Sens. Environ., 111, 69–88, https://doi.org/10.1016/j.rse.2007.03.012, 2007.

Table S1. Monthly average, 1 standard deviation and 95% confidence interval of nanoparticles (2.5–10 nm in diameter, $CN_{2.5\text{-}10}$) that originated from the Bellingshausen and Weddell Seas during the study period (from 2009 to 2016). A *t*-test was used to determine if there is a statistically significant differences between the means number concentration of nanoparticles originated from the two selected ocean domains.

		Avg.	Std.	95% confidence interval*		*p*-value (*t*-test)
				Lower bound	Upper bound	
Jan.	Weddell sea	332.0	920.7	196.3	782.4	0.0003
	Bellingshausen sea	835.9	2673.2	705.9	1004	
Feb.	Weddell sea	254.3	284.0	181.4	355.8	0.0010
	Bellingshausen sea	523.7	2130.7	417.2	695.4	
Mar.	Weddell sea	60.7	60.3	47.0	78.2	< 0.0001
	Bellingshausen sea	166.6	550.3	142.6	208.5	
Apr.	Weddell sea	70.0	103.6	53.9	96.4	0.0245
	Bellingshausen sea	100.9	272.4	87.7	126.6	
May	Weddell sea	89.6	74.5	75.2	108.4	< 0.0001
	Bellingshausen sea	45.2	56.2	41.0	50.9	
Jun.	Weddell sea	58.0	22.0	NaN**	NaN	NaN
	Bellingshausen sea	57.7	62.1	52.7	64.1	
Jul.	Weddell sea	22.9	17.9	15.1	35.1	0.0031
	Bellingshausen sea	42.8	56.8	36.8	51.6	
Aug.	Weddell sea	-	-	NaN	NaN	NaN
	Bellingshausen sea	58.3	78.6	47.5	73.6	
Sep.	Weddell sea	3.7	-	NaN	NaN	NaN
	Bellingshausen sea	97.9	85.9	91.0	105.5	
Oct.	Weddell sea	193.1	160.5	NaN	NaN	NaN
	Bellingshausen sea	129.0	405.1	110.3	197.7	
Nov.	Weddell sea	88.0	61.0	74.3	107.4	< 0.0001
	Bellingshausen sea	176.7	331.9	154.0	214.3	
Dec.	Weddell sea	200.5	380.5	56.5	499.9	0.2111
	Bellingshausen sea	343.0	1138.8	277.6	449.0	

*confidence interval was estimated by bootstrap method that was calculated from 10,000 subsamples generated by random sampling with replacement from monthly $CN_{2.5\text{-}10}$ data.
**number of hourly $CN_{2.5\text{-}10}$ data <10 was excluded from the bootstrap and *t*-test.

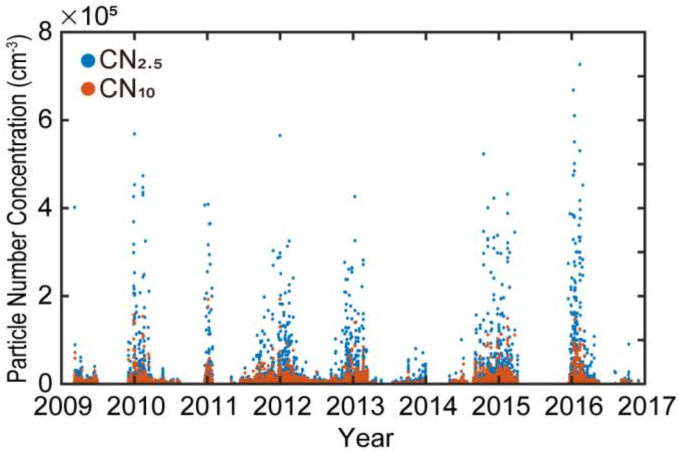

Figure S1: Hourly variations in the number concentration of particles > 2.5 nm in diameter ($CN_{2.5}$, blue symbols) and the number concentration of particles > 10 nm in diameter (CN_{10}, red symbols) from March 2009 to November 2016.

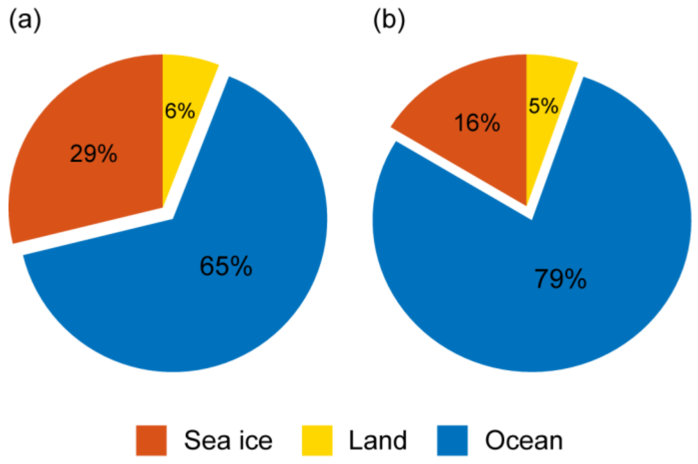

Figure S2: Percentage of the hourly trajectory points that passed over the three major areas surrounding the observation site including sea-ice (red), land (yellow) and ocean (blue) to the total number of hourly trajectory points in the 2-day air-mass trajectory during (a) the overall period (from January to December) and (b) the austral summer period (December, January and February) between March 2009 and November 2016.

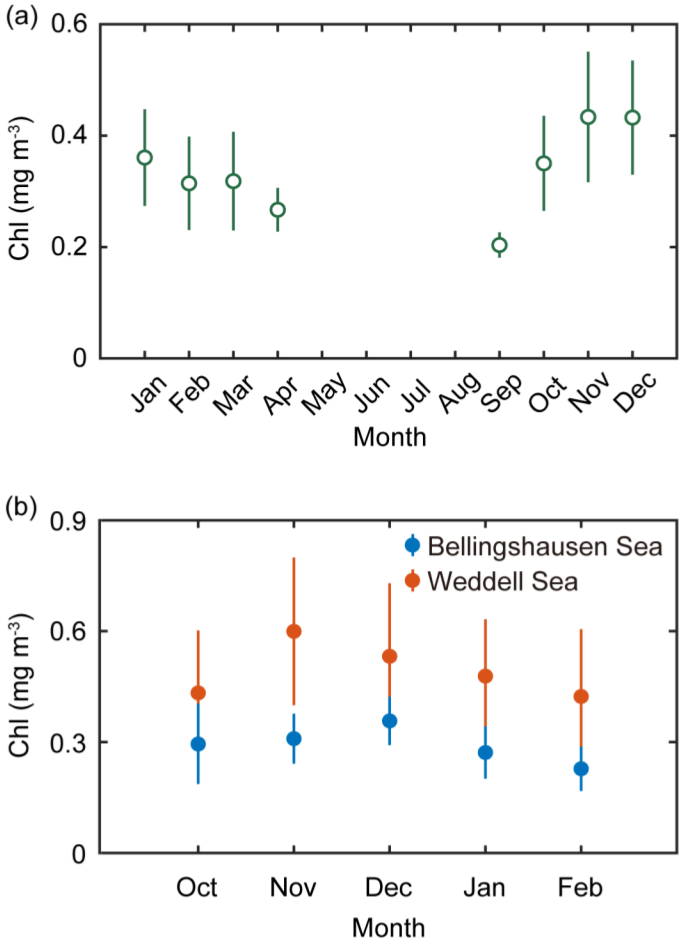

Figure S3: (a) Monthly mean chlorophyll concentration around the observation site between 2009 and 2016 (55ºS–65ºS, 40ºW–80ºW). (b) Monthly mean chlorophyll concentration for the two selected ocean domains including the Weddell (red symbols; 55ºS–65ºS, 40ºW–60ºW) and Bellingshausen (blue symbols; 55ºS–65ºS, 60ºW–80ºW) seas during the phytoplankton bloom period (October–February). Note that the monthly mean chlorophyll concentration was not available from May to August due to insufficient satellite-derived values (less than 10%) during the austral winter period.

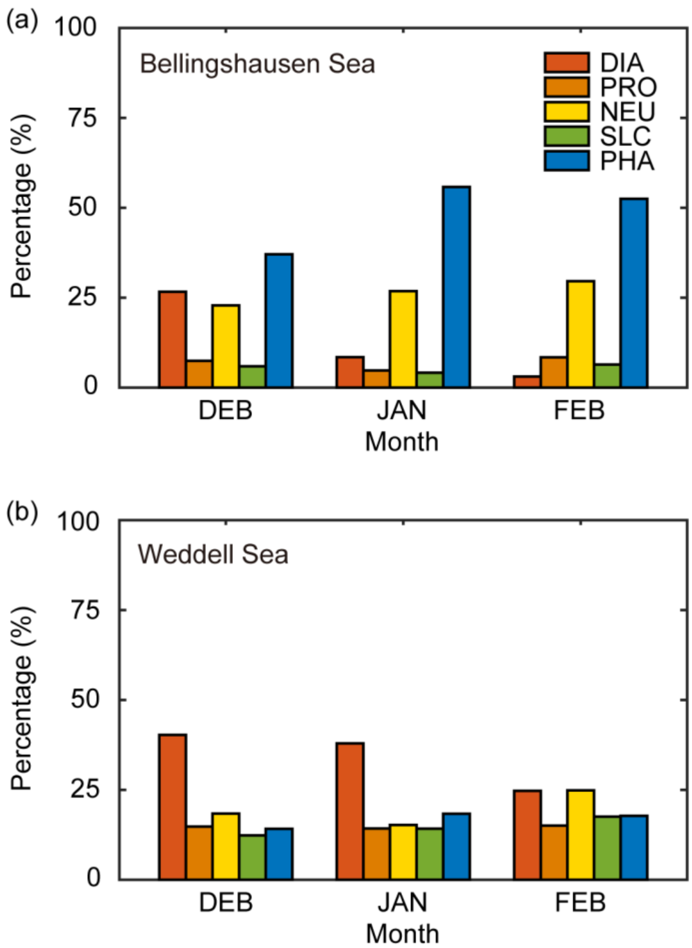

Figure S4: The percentage of the dominant phytoplankton groups in the two ocean domains including (a) the Bellingshausen and (b) Weddell seas estimated using the PHYSAT method during the austral summer period between 1997 and 2010.

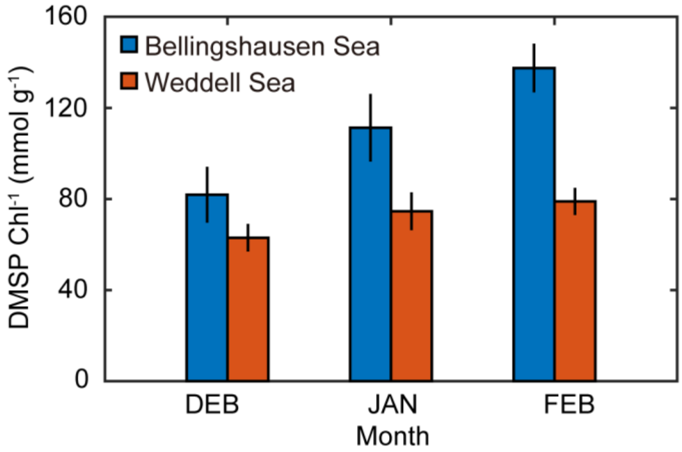

Figure S5: Monthly mean DMSP to chlorophyll ratio in the Bellingshausen (blue bars) and Weddell (red bars) seas during the austral summer period between March 2009 and November 2016.

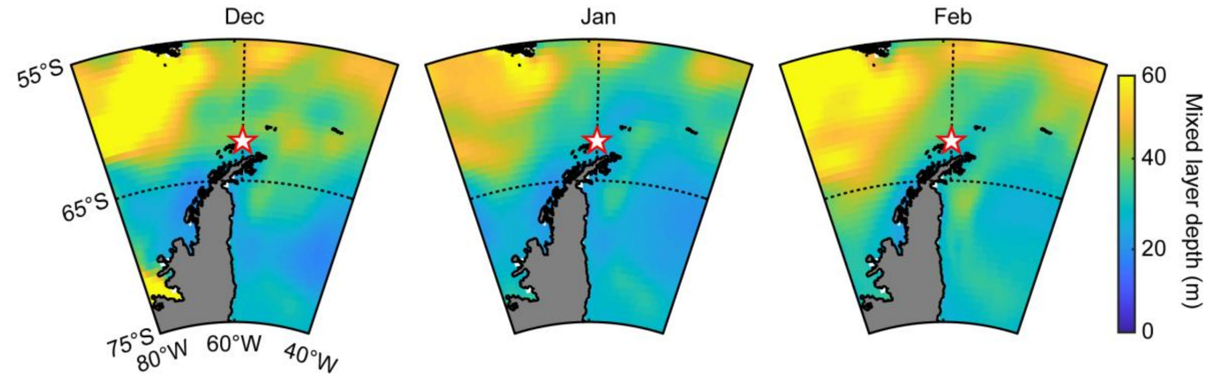

Figure S6: Mixed layer depth retrieved using the Monthly Isopycnal and Mixed-layer Ocean Climatology (MIMOC) during the austral summer period surrounding King Sejong Station (red star symbol).