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High-resolution underway measurements of phytoplankton photosynthesis and abundance as an innovative addition to water quality monitoring programs

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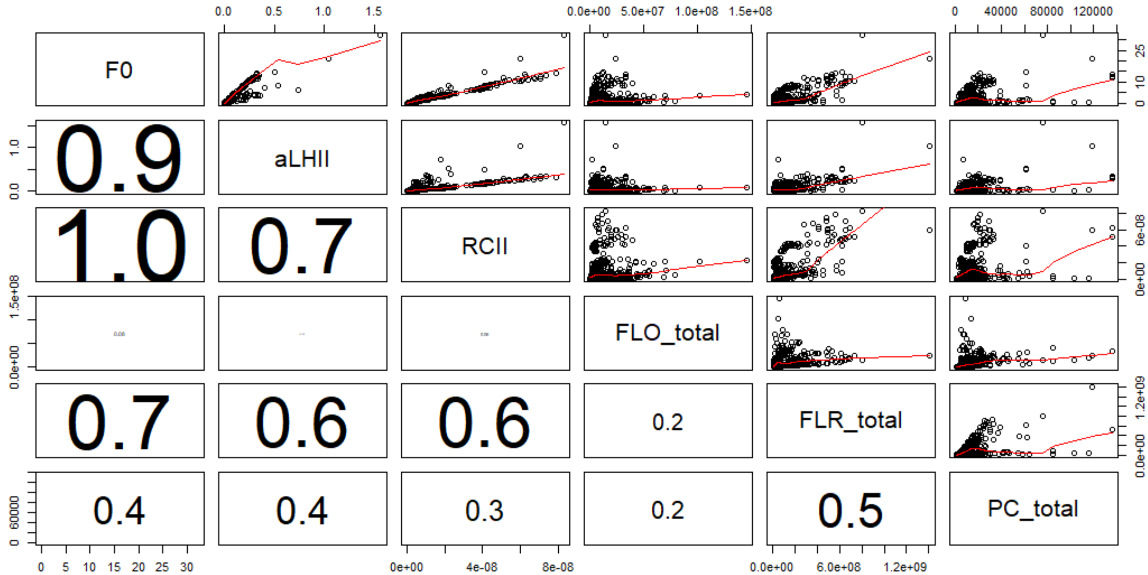

Figure S1: Pairplot of parameters informative on total phytoplankton abundance of the combined data of all cruises. F0, aLHII and RCII are derived from FRRf measurements. FLO_total, FLR_total and PC_total from FCM.

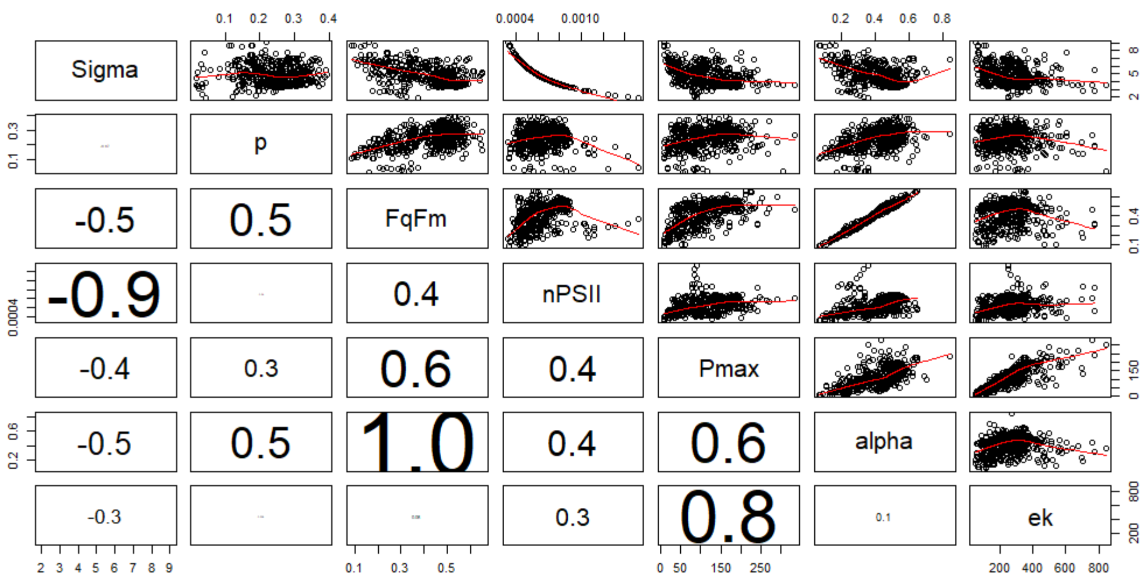

Figure S2: Pairplot of parameters informative on photophysiology of the phytoplankton as derived by FRR fluorometry.

Table S1: Monthly averages ± SD of abiotic conditions and biological parameters. Monthly averages are approximates and not comparable due to differences in sampling route and stations; In April and June the cruises did not go as far east as Rottum, In April the cruise consists of less coastal coverage and in May the cruise does not go 235 km offshore but only until 135 km (see Fig 3). Large standard deviations are due to spatial heterogeneity, for a more detailed description of the spatial heterogeneity; see figure 4 and the supplementary material. P_{max} and alpha are based on relative electron transport rates.

	April	May	June	August
Abiotics				
Salinity (‰)	34.1 ± 1.8	33.6 ± 1.8	33.6 ± 1.8	34.0 ± 1.4
SST (°C)	9.5 ± 1.0	12.1 ± 1.1	15.5 ± 1.8	19.0 ± 0.9
Turbidity (NTU)	2.3 ± 3.0	1.1 ± 0.8	1.3 ± 1.3	1.2 ± 1.3
PO_4 (µM)	0.3 ± 0.1	0.2 ± 0.1	0.3 ± 0.1	0.3 ± 0.1
Si (µM)	3.2 ± 3.0	1.8 ± 1.5	1.0 ± 0.6	1.3 ± 1.1
NH_4 (µM)	1.0 ± 1.1	1.2 ± 0.9	1.5 ± 1.2	0.4 ± 0.4
$NO_3 + NO_2$ (µM)	10.3 ± 12.5	3.4 ± 5.5	1.0 ± 1.1	0.1 ± 0.2
DIN:DIP	39.0 ± 52.5	26.9 ± 42.1	7.5 ± 5.3	2.3 ± 2.1
DSi:DIP	6.4 ± 6.5	9.9 ± 9.2	4.1 ± 2.5	5.7 ± 3.9
K_d (m^{-1})	0.39 ± 0.28	0.33 ± 0.12	0.30 ± 0.20	0.25 ± 0.14
Biotics				
Chlorophyll *a* (µg L^{-1})	18.32 ± 19.71	5.67 ± 10.39	4.08 ± 4.11	3.98 ± 3.91
F_v/F_m	0.52 ± 0.04	0.26 ± 0.09	0.40 ± 0.09	0.48 ± 0.07
σ_{PSII} (nm^2 $PSII^{-1}$)	3.67 ± 0.30	5.92 ± 1.35	4.59 ± 0.88	5.26 ± 1.07
[RCII] (*10^{-9} nmol RCII m^{-3})	32.4 ± 21.8	5.82 ± 10.4	4.31 ± 2.72	2.21 ± 1.84
n_{PSII} (*10^{-4} RCII (Chl a)$^{-1}$)	8.00 ± 0.58	5.30 ± 1.75	6.57 ± 1.67	5.95 ± 1.15
$1/\tau$ (ms^{-1})	0.24 ± 0.06	0.52 ± 0.10	0.49 ± 0.07	0.62 ± 0.12
α	0.53 ± 0.03	0.25 ± 0.09	0.39 ± 0.08	0.48 ± 0.08
E_k	300 ± 52.5	223 ± 147	253 ± 124	277 ± 137
P_{max}	158 ± 30	56.5 ± 42.4	97.5 ± 47.7	130 ± 60.4
GPP water column (mg C m^{-2} h^{-1})	781 ± 409	207 ± 277	136 ± 101	68.4 ± 39.1
GPP surface (µg C L^{-1} h^{-1})	115.7 ± 58	27.5 ± 72	16.5 ± 13	8.7 ± 8.3
O:R ratio	0.31 ± 0.52	0.07 ± 0.09	0.20 ± 0.20	0.27 ± 0.16
Rel. abundance microphytoplankton (%)	0.6 ± 0.6	3.5 ± 4.4	2.0 ± 2.0	0.4 ± 0.6
Rel. abundance Nanophytoplankton (%)	27.6 ± 17.2	41.3 ± 17.8	21.6 ± 8.0	18.1 ± 8.0
Rel. abundance Picophytoplankton (%)	71.8 ± 17.5	55.2 ± 19.0	76.3 ± 9.2	81.5 ± 6.0

Table S2: nutrient concentrations (micromol/L) for the different stations for the Months April, May, June and August. The stations are named according to name of the transects (from South to North: off the coast from Walcheren (WALCRN), Noordwijk (NOORDWK) and Terschelling (TERSLG)) and the distance in kilometres from the coast. Potentially limiting nutrient concentrations are colored red, we used threshold concentration for DIN and Si as 2 µmol L^{-1} and PO_4^{3-} as 0.2 µmol L^{-1} (Peperzak et al, 1991, Philippart et al., 2007), although Ly et al. (2014) showed that for Wadden Sea phytoplankton phosphate can become limiting when values become lower than 0.13-0.16 µmol L^{-1}.

	DIN (µM)				PO_4 (µM)				Si (µM)			
Station	April	May	June	August	April	May	June	August	April	May	June	August
WALCRN2	1.0	2.4	3.4	1.0	0.2	0.2	0.4	0.6	0.6	0.7	1.4	1.9
WALCRN20	1.2	3.1	1.1	0.3	0.1	0.1	0.3	0.3	0.2	2.7	0.5	2.0
WALCRN70	1.1	1.2	1.1	0.3	0.2	0.2	0.2	0.1	0.0	0.6	0.4	0.9
NOORDWK2	37.5	21.7	4.9	0.4	0.3	0.6	0.2	0.2	6.7	3.5	0.8	1.2
NOORDWK10	28.5	15.0	3.1	0.6	0.2	0.1	0.4	0.1	2.9	3.2	0.7	1.4
NOORDWK20	21.6	4.9	0.9	0.2	0.2	0.1	0.2	0.1	1.3	0.7	0.8	0.6
NOORDWK70	0.4	1.0	0.9	0.1	0.2	0.2	0.3	0.2	0.0	1.1	1.7	0.1
TERSLG10	10.1	1.9	0.9	0.6	0.3	0.2	0.2	0.2	3.0	2.4	0.5	0.7
TERSLG50	8.9	0.7	3.4	2.8	0.5	0.2	0.2	0.3	4.6	1.7	2.4	5.0
TERSLG100	12.6	0.7	1.9	0.3	0.5	0.2	0.3	0.2	3.9	0.5	1.1	1.7
TERSLG135	1.6	0.8	0.9	0.2	0.4	0.1	0.1	0.3	2.0	0.8	0.9	1.8
TERSLG175	0.9	NA	1.0	0.0	0.2	NA	0.2	0.2	0.6	NA	0.5	0.1
TERSLG235	1.0	NA	0.9	0.6	0.2	NA	0.3	0.3	0.0	NA	1.1	0.5