Electronic Supplementary Material

This supplementary material has not been peer reviewed.

Title: **Seasonal Nitrogen Fluxes of the Lena River Delta**

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S 1: Supplementing information

Soil analysis regarding total carbon and nitrogen content

In soil and sediment samples total soil carbon and nitrogen were measured with an elemental analyzer (VarioMAX Elementar Analysensysteme GmbH, Hanau, Germany) after the soil has been sieved (< 2 mm), milled, and dried at 105 °C.

Soil Texture analysis

For texture analysis, the samples were digested with H$_2$O$_2$ to destroy organic matter when TOC content was >1 % and with HCl to destroy carbonates when CaCO$_3$ content was >2 %. The sand fractions were determined by dry sieving at four mesh sizes (630, 200, 125,63 μm). Silt fractions and clay were measured according to DIN ISO 11277 (Sedimat 4–12, UGT GmbH, Müncheberg, Germany).

KCl extraction for dissolved inorganic nitrogen (DIN) in soils

Inorganic nitrogen compounds were extracted from 10 g moist soil with 20 ml of 0.0125 mM KCl solution. For determination of nitrate, nitrate and ammonium concentrations, frozen KCl extracts were transported to Hamburg, where nitrate (and nitrite) concentrations were measured by HPLC (MEINKE et al. 1992). In all samples, nitrite was not detectable (below 1 μmol L$^{-1}$). Ammonium concentrations by photometer (lowest detectable value 1 μmol l$^{-1}$) (DIN 38406–E5-1).

Suspension particulate matter (SPM)

Filter samples, were dried at 50 °C and weighed for later determination of C/N ratios, suspended particulate matter (SPM) content, and δ15N-SPM analysis. C/N ratios were determined with an elemental analyzer (Eurovector EA 3000) calibrated against a certified acetanilide standard (IVA Analysentechnik, Germany). The standard deviation of C/N analysis was 0.05 % for carbon and 0.005 % for nitrogen.

δ15N SPM was analysed with an element analyser (Carlo Erba NA 2500) coupled with an isotope ratio mass spectrometer (Finnigan MAT 252). where the standards for nitrogen and oxygen are atmospheric N$_2$ and Vienna Standard Mean Ocean Water (VSMOW), respectively.
International isotope standards IAEA N1, IAEA N2, and a certified sediment standard (IVA Analysentechnik, Germany) for suspended matter isotope values.

**Dissolved Organic carbon (DOC)**

Water samples for DOC analysis were filtered through 0.7 µm pore-size filters in the field, acidified with 20 µl concentrated (35%) hydrochloric acid (HCl) and kept cool in a lab refrigerator at 4°C. DOC was measured as non–purgeable organic carbon (NPOC) using a total organic carbon analyser TOC-VCPH/CPN from SHIMADZU at AWI Potsdam. Two mL of water were diluted with 10 mL of distilled water and filled into small test tubes. The tubes were placed into an auto-sampler. During the measurement, sparge gas was first bubbled through the sample and hydrochloric acid was added to remove inorganic carbon by converting it to carbon dioxide. The remaining organic carbon is measured by combusting the sample at 680°C and measuring the CO₂ concentration. To ensure the accuracy of the measurement, blank samples of ultra-pure water and standards with known DOC concentrations were run before and after the measurement and then in regular intervals.

**Total and dissolved organic Nitrogen (TN/TDN) and Phosphorus (TP/TDP)**

For the determination of DON, we used the persulfate oxidation method (Knapp et al., 2005). The first step is the oxidation of total dissolved nitrogen (TDN, the sum of nitrate, nitrite, ammonium and DON) to nitrate. For the oxidation of TDN to nitrate, 24 ml of the sample plus 2 ml of persulfate oxidizing reagent (POR) was added to a Teflon bottle. The POR contains ACS-grade sodium hydroxide, certified ACS-grade boric acid and certified ACS-grade potassium persulfate, which was recrystallized three times (Hansen and Koroleff 2007). For the digestion a microwave (CEM, Mars 5) was used. The reagent blank was always <2 µM. DON concentrations were calculated by subtracting the DIN concentrations. As reference, internal standards of ammonium sulfate and urea were used.

In the same digestion also the total phosphorus were measured. Reagent blank was below 0.1 µM.

For the analysis of total nitrogen and phosphorus unfiltered we have used the same method using unfiltered water samples.

**Inorganic nutrient analysis**

All filtered water samples were analyzed in duplicate for concentration of ammonium, nitrite, nitrate, phosphate and silicate using an automated continuous flow system (AA3, Seal
Analytical, Germany) and standard colorimetric techniques (Hansen and Koroleff 2007). Detection limits were 1 μmol L$^{-1}$ for nitrate and silicate, 0.5 μmol L$^{-1}$ for nitrite, ammonium and phosphate.

**Nutrient Analysis of Lena River Monitoring Program by the OSL**

Inorganic nutrients (nitrate, nitrite, ammonium, silicate and phosphate), TN samples from Lena River Monitoring program were delivered from sampling site and stored frozen (-24°C) until analyzed on automated continuous flow system (San+, SKALAR, Netherlands) with standard colorimetric techniques (Aminot et al. 2009). TN protocols were identical to above mentioned technique of peroxide-based wet oxidation with microwave digestion replaced by autoclaving at 121°C. Environmental matrix reference materials (Environment and Climate Change Canada) were used as tracking standard in every batch of samples.

**N$_2$O production measurements**

Potential Aerobic nitrous oxide production rates were determined in incubation tests with the soil samples taken during expedition in August 2019, directly frozen in the field and thawed in a refrigerator for three days in March 2019. After removing stones, roots and other plant material samples were homogenized by sieving for mineral soils (2 mm mesh size) or by hand mixing and cutting with scissors for peat rich material. 1 g fresh weight of homogenized soil were weighted in 100-ml-serum bottles, 20 ml of Lena water were added and and the bottle were sealed air-tight with rubber thick septa. Soil samples were incubated at 5 °C, without shaking in the dark in 18 replicates. At the begining, and after 1, 2, 8, 11, 18 weeks 1ml-gas samples were taken from three samples and concentrations of N$_2$O was determined by gas chromatography (GC, Agilent Technologies 7890 A, Santa Clara, CA, USA). Before the gas measurements at GC, partial pressure were measured in all flasks (KELLER, Mano 2000 Leo 1, Switzerland). In case of low pressure in incubation flasks, 500 µl N$_2$ was injected. The injection volume for gas analysis was 250 µL. Gases were separated on a Porapak Q column (1.8 m length, 2 mm ID) and quantified with an electron capture detector (ECD). The inflow, oven, and detector temperature was 360 °C (ECD), respectively. Nitrogen served as the carrier gas (30 mL min$^{-1}$). The mixing ratios (ppm) were calculated from the peak areas based on a standard curve with 3 different levels of N$_2$O concentrations, ranging from 0.29-1.55 ppm. The total amount of N$_2$O was calculated from the partial pressure of the gases, the
temperature, the headspace volume, the amount of water and the water solubility of N$_2$O. Aerobic N$_2$O production only started after a lag phase, so production rates were calculated as a function of time after 8 weeks of incubation, where maximal N$_2$O was produced over time.
Supplementary Table S1
Data are related to https://doi.pangaea.de/10.1594/PANGAEA.933187

| Sample Number | Longitude  | Latitude      | Date       | Bot. Depth | Temperature | Salinity |
|---------------|------------|---------------|------------|------------|-------------|----------|
| SUMMER        |            |               |            | m          | °C          | PSU      |
| LEN19_S_01_01 | 126.695646 | 72.3993839    | 2019-08-09 | 19         | 15.95       | 0.08     |
| LEN19_S_01_18 | 126.695646 | 72.3993839    | 2019-08-09 | 19         | 15.99       | 0.08     |
| LEN19_S_02_1  | 126.9289955| 72.5373429    | 2019-08-09 | 17         | 15.95       | 0.08     |
| LEN19_S_02_16 | 126.9289955| 72.5373429    | 2019-08-09 | 17         | 15.97       | 0.08     |
| LEN19_S_02_Bottom | 126.9289955| 72.5373429 | 2019-08-09 | 17         | 15.98       | 0.08     |
| LEN19_S_03_1  | 127.4193214| 72.6270543    | 2019-08-09 | 6          | 15.74       | 0.08     |
| LEN19_S_04_1  | 127.9591821| 72.6335186    | 2019-08-09 | 3          | 15.18       | 0.08     |
| LEN19_S_05_1  | 128.2446629| 72.5638046    | 2019-08-09 | 5          | 15.25       | 0.08     |
| LEN19_S_05_4  | 128.2446629| 72.5638046    | 2019-08-09 | 5          | 15.22       | 0.08     |
| LEN19_S_06_1  | 128.5154812| 72.5211118    | 2019-08-08 | 8          | 15.49       | 0.08     |
| LEN19_S_06_6  | 128.5154812| 72.5211118    | 2019-08-08 | 8          | 15.49       | 0.08     |
| LEN19_S_07_1  | 128.6950478| 72.4613355    | 2019-08-08 | 18         | 14.99       | 0.08     |
| LEN19_S_07_15 | 128.6950478| 72.4613355    | 2019-08-08 | 18         | 15.02       | 0.08     |
| LEN19_S_07_8  | 128.8410507| 72.4530305    | 2019-08-08 | 10         | 15.00       | 0.08     |
| LEN19_S_08_1  | 128.9707677| 72.4770465    | 2019-08-08 | 8          | 14.93       | 0.08     |
| LEN19_S_08_6  | 128.9707677| 72.4770465    | 2019-08-08 | 8          | 14.91       | 0.08     |
| LEN19_S_89_1  | 129.0992231| 72.5016874    | 2019-08-08 | 13         | 14.98       | 0.08     |
| LEN19_S_89_6  | 129.0992231| 72.5016874    | 2019-08-08 | 13         | 14.75       | 0.08     |
| LEN19_S_89_12 | 129.0992231| 72.5016874    | 2019-08-08 | 13         | 14.56       | 0.08     |
| LEN19_S_09_1  | 129.2484149| 72.5090431    | 2019-08-08 | 11         | 14.91       | 0.08     |
| LEN19_S_09_5  | 129.2484149| 72.5090431    | 2019-08-08 | 11         | 14.45       | 0.08     |
| LEN19_S_09_10 | 129.2484149| 72.5090431    | 2019-08-08 | 11         | 14.45       | 0.08     |
| Sample Number     | Nitrite | Silicate | Phosphate | Ammonium | Nitrate |
|-------------------|---------|----------|-----------|----------|---------|
| SUMMER            | µmol L-1| µmol L-1 | µmol L-1  | µmol L-1 | µmol L-1|
| LEN19_S_01_01     | 0.10    | 48.66    | 0.07      | 0.74     | 1.44    |
| LEN19_S_01_18     | 0.11    | 25.75    | 0.07      | 0.76     | 1.38    |
| LEN19_S_02_1      | 0.12    | 22.89    | 0.06      | 0.78     | 1.04    |
| LEN19_S_02_16     | 0.09    | 60.57    | 0.06      | 0.77     | 1.09    |
| LEN19_S_02_Bottom | 0.15    | 21.79    | 0.09      | 0.76     | 1.22    |
| LEN19_S_03_1      | 0.11    | 18.78    | 0.05      | 0.79     | 0.65    |
| LEN19_S_04_1      | 0.12    | 18.78    | 0.05      | 0.75     | 0.28    |
| LEN19_S_05_1      | 0.10    | 16.31    | 0.04      | 0.66     | 0.25    |
| LEN19_S_05_4      | 0.10    | 17.05    | 0.04      | 0.65     | 0.25    |
| LEN19_S_06_1      | 0.07    | 27.20    | 0.04      | 0.55     | 0.26    |
| LEN19_S_06_6      | 0.10    | 20.47    | 0.05      | 0.47     | 0.21    |
| LEN19_S_07_1      | 0.10    | 25.29    | 0.04      | 0.27     | 0.16    |
| LEN19_S_07_15     | 0.08    | 39.95    | 0.04      | 0.35     | 0.25    |
| LEN19_S_07_8      | 0.10    | 30.75    | 0.04      | 0.22     | 0.16    |
| LEN19_S_08_1      | 0.07    | 59.03    | 0.05      | 0.26     | 0.18    |
| LEN19_S_08_6      | 0.10    | 21.57    | 0.03      | 0.17     | 0.12    |
| LEN19_S_08_6      | 0.09    | 24.37    | 0.03      | 0.16     | 0.15    |
| LEN19_S_09_1      | 0.09    | 29.64    | 0.04      | 0.15     | 0.20    |
| LEN19_S_09_6      | 0.09    | 29.98    | 0.03      | 0.15     | 0.19    |
| LEN19_S_09_12     | 0.09    | 30.48    | 0.04      | 0.15     | 0.19    |
| LEN19_S_09_1      | 0.10    | 29.10    | 0.04      | 0.15     | 0.20    |
| LEN19_S_09_5      | 0.09    | 29.51    | 0.04      | 0.22     | 0.27    |
| LEN19_S_09_10     | 0.10    | 32.72    | 0.04      | 0.23     | 0.27    |
| Sample Number     | TDN  | DON  | TDP  | TN   | TP   | DOC  | DON  |
|-------------------|------|------|------|------|------|------|------|
| SUMMER            | µmol L-1 | µmol L-1 | µmol L-1 | µmol L-1 | µmol L-1 | mg L-1 | mg L-1 |
| LEN19_S_01_01     | 16.13 | 14.59 | 0.14 | 15.67 | 0.40 | 5.44 | 0.20 |
| LEN19_S_01_18     | 12.62 | 11.13 | 0.10 | 15.81 | 0.36 | 5.88 | 0.16 |
| LEN19_S_02_1      | 11.49 | 10.33 | 0.09 | 14.68 | 0.32 | 5.53 | 0.14 |
| LEN19_S_02_16     | 12.20 | 11.01 | 0.09 | 15.62 | 0.31 | 5.75 | 0.15 |
| LEN19_S_02_Bottom | 13.67 | 12.31 | 0.15 | 17.65 | 0.65 |      |      |
| LEN19_S_03_1      | 11.67 | 10.92 | 0.10 | 14.81 | 0.31 | 5.72 | 0.15 |
| LEN19_S_04_1      | 12.32 | 11.92 | 0.10 | 15.09 | 0.32 | 5.68 | 0.17 |
| LEN19_S_05_1      | 11.54 | 11.19 | 0.10 | 15.03 | 0.30 | 5.36 | 0.16 |
| LEN19_S_05_4      | 12.20 | 11.86 | 0.12 | 17.21 | 0.45 | 5.54 | 0.17 |
| LEN19_S_06_1      | 11.73 | 11.41 | 0.10 | 17.52 | 0.44 | 5.37 | 0.16 |
| LEN19_S_06_6      | 11.92 | 11.62 | 0.08 | 17.56 | 0.47 | 5.92 | 0.16 |
| LEN19_S_07_1      | 12.24 | 11.98 | 0.10 | 15.28 | 0.38 | 5.59 | 0.17 |
| LEN19_S_07_15     | 12.94 | 12.60 | 0.10 | 15.80 | 0.36 | 5.36 | 0.18 |
| LEN19_S_07_8      | 13.13 | 12.89 | 0.08 | 16.87 | 0.39 | 5.44 | 0.18 |
| LEN19_S_08_1      | 13.58 | 13.33 | 0.09 | 15.48 | 0.38 | 5.72 | 0.19 |
| LEN19_S_08_6      | 12.51 | 12.29 | 0.09 | 15.94 | 0.42 | 5.46 | 0.17 |
| LEN19_S_08_6      | 12.72 | 12.48 | 0.10 | 15.02 | 0.40 | 5.49 | 0.17 |
| LEN19_S_89_1      | 12.18 | 11.89 | 0.07 | 15.54 | 0.37 | 5.30 | 0.17 |
| LEN19_S_89_6      | 12.90 | 12.62 | 0.09 | 16.51 | 0.37 | 5.28 | 0.18 |
| LEN19_S_89_12     | 13.23 | 12.95 | 0.08 | 15.79 | 0.36 | 5.33 | 0.18 |
| LEN19_S_09_1      | 13.26 | 12.95 | 0.07 | 15.66 | 0.35 | 5.55 | 0.18 |
| LEN19_S_09_5      | 13.13 | 12.78 | 0.08 | 16.87 | 0.39 | 5.67 | 0.18 |
| LEN19_S_09_10     | 12.31 | 11.94 | 0.08 | 15.63 | 0.36 | 5.53 | 0.17 |
| Sample Number  | SPM  | Total Nitrogen | Total Carbon | C/N |
|---------------|------|----------------|--------------|-----|
| SUMMER        |      |                |              |     |
| LEN19_S_01_01 | 12.54| 0.55           | 4.49         | 8.74|
| LEN19_S_01_18 | 23.51| 0.45           | 4.39         | 9.86|
| LEN19_S_02_1  | 9.52 | 0.55           | 4.33         | 7.89|
| LEN19_S_02_16 | 9.26 | 0.71           | 5.62         | 7.88|
| LEN19_S_02_Bottom |  |                |              |     |
| LEN19_S_03_1  | 9.19 | 0.63           | 5.39         | 8.58|
| LEN19_S_04_1  | 9.31 | 0.66           | 5.47         | 8.29|
| LEN19_S_05_1  | 9.83 | 0.73           | 6.14         | 8.47|
| LEN19_S_05_4  | 11.26| 0.69           | 5.95         | 8.64|
| LEN19_S_06_1  | 11.72| 0.62           | 5.48         | 8.84|
| LEN19_S_06_6  | 11.40| 0.70           | 6.05         | 8.59|
| LEN19_S_07_1  | 7.59 | 0.81           | 7.39         | 9.12|
| LEN19_S_07_15 | 9.46 | 0.78           | 6.43         | 8.28|
| LEN19_S_08_1  | 9.06 | 0.61           | 5.30         | 8.72|
| LEN19_S_08_8  | 10.02| 0.71           | 7.02         | 9.91|
| LEN19_S_08_1  | 9.65 | 0.84           | 7.16         | 8.50|
| LEN19_S_08_6  | 9.74 | 0.60           | 5.46         | 9.13|
| LEN19_S_09_1  | 7.18 | 0.99           | 7.90         | 7.95|
| LEN19_S_09_6  | 7.69 | 1.09           | 8.57         | 7.88|
| LEN19_S_09_12 | 8.35 | 0.92           | 7.60         | 8.29|
| LEN19_S_09_1  | 5.92 | 1.37           | 9.93         | 7.22|
| LEN19_S_09_S  | 7.40 | 1.05           | 8.46         | 8.08|
| LEN19_S_09_10 | 7.22 | 1.22           | 8.87         | 7.29|
| Sample Number | TDN/TDP | DON/TDP | Nitrate / Phosphate | TN/TP | DOC/DON |
|---------------|---------|---------|---------------------|-------|---------|
| SUMMER        |         |         |                     |       |         |
| LEN19_S_01_01 | 112.80  | 102.01  | 21.82               | 38.88 | 26.65   |
| LEN19_S_01_18 | 126.59  | 111.63  | 21.22               | 43.71 | 37.74   |
| LEN19_S_02_1  | 132.60  | 119.24  | 18.16               | 46.41 | 38.2    |
| LEN19_S_02_16 | 130.91  | 118.20  | 17.87               | 51.11 | 37.31   |
| LEN19_S_02_Bottom | 92.81 | 83.55  | 13.84               | 27.25 |         |
| LEN19_S_03_1  | 117.13  | 109.55  | 12.42               | 47.14 | 37.4    |
| LEN19_S_04_1  | 123.59  | 119.57  | 5.62                | 47.71 | 34.05   |
| LEN19_S_05_1  | 118.36  | 114.75  | 6.00                | 50.62 | 34.21   |
| LEN19_S_05_4  | 104.30  | 101.34  | 5.68                | 38.57 | 33.38   |
| LEN19_S_06_1  | 115.17  | 112.00  | 6.12                | 39.44 | 33.66   |
| LEN19_S_06_6  | 144.74  | 141.08  | 4.58                | 37.69 | 36.39   |
| LEN19_S_07_1  | 125.53  | 122.89  | 4.47                | 40.06 | 33.3    |
| LEN19_S_07_15 | 132.67  | 129.25  | 6.02                | 43.92 | 30.35   |
| LEN19_S_78_1  | 159.53  | 156.51  | 4.30                | 42.77 | 30.15   |
| LEN19_S_78_8  | 149.24  | 146.48  | 3.93                | 41.06 | 30.62   |
| LEN19_S_08_1  | 137.50  | 135.03  | 3.81                | 38.31 | 31.76   |
| LEN19_S_08_6  | 133.43  | 130.95  | 4.35                | 37.87 | 31.41   |
| LEN19_S_89_1  | 165.35  | 161.43  | 5.50                | 42.44 | 31.81   |
| LEN19_S_89_6  | 138.49  | 135.47  | 5.70                | 44.29 | 29.88   |
| LEN19_S_89_12 | 160.63  | 157.23  | 5.34                | 43.63 | 29.40   |
| LEN19_S_09_1  | 179.97  | 175.83  | 5.37                | 44.35 | 30.59   |
| LEN19_S_09_5  | 159.53  | 155.17  | 7.19                | 42.77 | 31.72   |
| LEN19_S_09_10 | 145.69  | 141.33  | 7.13                | 42.94 | 33.06   |
| Sample Number  | Longitude     | Latitude     | Date       | Bot. Depth | Temperature | Salinity |
|---------------|---------------|--------------|------------|------------|-------------|----------|
| SUMMER        |               |              |            |            |             |          |
| CAC_04_1      | 130.1263035   | 72.5301281   | 2019-08-03 | 7          | 10.05       | 2.95     |
| CAC_04_6      | 130.1263035   | 72.5301281   | 2019-08-03 | 7          | 4.56        | 18.78    |
| CAC_04_Bottom | 130.1263035   | 72.5301281   | 2019-08-03 | 7          | 3.87        | 22.91    |
| CAC_05_1      | 130.4335066   | 72.5398332   | 2019-08-03 | 13         | 9.82        | 3.46     |
| CAC_05_6      | 130.4335066   | 72.5398332   | 2019-08-03 | 13         | 5.82        | 14.74    |
| CAC_05_12     | 130.4335066   | 72.5398332   | 2019-08-03 | 13         | -0.05       | 27.64    |
| CAC_05_Bottom | 130.4335066   | 72.5398332   | 2019-08-03 | 13         | -0.03       | 27.67    |
| CAC_06_1      | 130.7224841   | 72.5411834   | 2019-08-03 | 17         | 9.06        | 4.10     |
| CAC_06_8      | 130.7224841   | 72.5411834   | 2019-08-03 | 17         | 5.54        | 15.26    |
| CAC_06_15     | 130.7224841   | 72.5411834   | 2019-08-03 | 17         | -0.60       | 27.89    |
| CAC_06_Bottom | 130.7224841   | 72.5411834   | 2019-08-03 | 17         | -0.62       | 27.94    |
| CAC_07_1      | 131.0183698   | 72.5505630   | 2019-08-03 | 20         | 9.07        | 4.87     |
| CAC_07_8      | 131.0183698   | 72.5505630   | 2019-08-03 | 20         | 3.58        | 18.40    |
| CAC_07_18     | 131.0183698   | 72.5505630   | 2019-08-03 | 20         | -0.87       | 28.27    |
| CAC_07_Bottom | 131.0183698   | 72.5505630   | 2019-08-03 | 20         | -0.90       | 28.29    |
| CAC_08_1      | 131.3146861   | 72.5544617   | 2019-08-03 | 21         | 8.81        | 3.95     |
| CAC_08_10     | 131.3146861   | 72.5544617   | 2019-08-03 | 21         | -0.41       | 25.34    |
| CAC_08_19     | 131.3146861   | 72.5544617   | 2019-08-03 | 21         | -1.03       | 28.92    |
| CAC_08_Bottom | 131.3146861   | 72.5544617   | 2019-08-03 | 21         | -0.97       | 28.94    |
| CAC_09_1      | 131.6060619   | 72.5588626   | 2019-08-03 | 22         | 6.67        | 2.37     |
| CAC_09_10     | 131.6060619   | 72.5588626   | 2019-08-03 | 22         | 1.00        | 20.44    |
| CAC_09_20     | 131.6060619   | 72.5588626   | 2019-08-03 | 22         | -1.10       | 29.33    |
| CAC_09_Bottom | 131.6060619   | 72.5588626   | 2019-08-03 | 22         | -1.09       | 29.36    |
| CAC_10_1      | 131.9148058   | 72.5532083   | 2019-08-03 | 22         | 5.55        | 2.70     |
| CAC_10_10     | 131.9148058   | 72.5532083   | 2019-08-03 | 22         | 0.12        | 18.60    |
| CAC_10_20     | 131.9148058   | 72.5532083   | 2019-08-03 | 22         | -1.08       | 29.17    |
| CAC_10_Bottom | 131.9148058   | 72.5532083   | 2019-08-03 | 22         | -1.04       | 29.14    |
| Sample Number | Nitrite | Silicate | Phosphate | Ammonium | Nitrate |
|---------------|---------|----------|-----------|----------|---------|
| SUMMER        | µmol L⁻¹ | µmol L⁻¹ | µmol L⁻¹ | µmol L⁻¹ | µmol L⁻¹ |
| CAC_04_1      | 0.05    | 14.62    | 0.04      | 0.14     | 0.05    |
| CAC_04_6      | 0.11    | 28.08    | 0.31      | 0.86     | 1.83    |
| CAC_04_Bottom | 0.21    | 32.49    | 0.24      | 6.56     | 3.44    |
| CAC_05_1      | 0.05    | 16.93    | 0.03      | 0.11     | 0.01    |
| CAC_05_6      | 0.08    | 21.97    | 0.12      | 1.54     | 0.07    |
| CAC_05_12     | 0.09    | 31.46    | 0.58      | 0.32     | 5.62    |
| CAC_05_Bottom | 0.08    | 33.67    | 0.67      | 0.47     | 5.58    |
| CAC_06_1      | 0.11    | 17.73    | 0.04      | 0.14     | 0.02    |
| CAC_06_8      | 0.06    | 29.75    | 0.11      | 0.23     | 0.13    |
| CAC_06_15     | 0.07    | 32.45    | 0.23      | 0.23     | 1.66    |
| CAC_06_Bottom | 0.10    | 33.04    | 0.67      | 0.23     | 6.24    |
| CAC_07_1      | 0.07    | 17.73    | 0.04      | 0.14     | 0.02    |
| CAC_07_8      | 0.08    | 29.75    | 0.06      | 0.28     | 0.05    |
| CAC_07_18     | 0.06    | 32.77    | 0.78      | 0.08     | 6.13    |
| CAC_07_Bottom | 0.10    | 41.74    | 1.12      | 0.72     | 6.40    |
| CAC_08_1      | 0.14    | 19.93    | 0.10      | 0.16     | 0.00    |
| CAC_08_10     | 0.09    | 36.38    | 0.18      | 0.15     | 2.45    |
| CAC_08_19     | 0.05    | 30.56    | 0.81      | 0.08     | 5.65    |
| CAC_08_Bottom | 0.05    | 30.98    | 0.79      | 0.13     | 5.41    |
| CAC_09_1      | 0.15    | 11.87    | 0.05      | 0.52     | 0.73    |
| CAC_09_10     | 0.17    | 28.37    | 0.07      | 1.53     | 0.69    |
| CAC_09_20     | 0.11    | 28.66    | 0.90      | 0.11     | 5.20    |
| CAC_09_Bottom | 0.05    | 28.43    | 0.81      | 0.15     | 5.18    |
| CAC_10_1      | 0.23    | 14.17    | 0.03      | 0.44     | 0.07    |
| CAC_10_10     | 0.19    | 35.22    | 0.16      | 0.56     | 2.03    |
| CAC_10_20     | 0.06    | 30.20    | 0.80      | 0.31     | 5.50    |
| CAC_10_Bottom | 0.07    | 35.20    | 0.59      | 0.27     | 3.62    |
| Sample Number | TDN  | DON  | TDP  | TN   | TP   | DOC  | DON  |
|---------------|------|------|------|------|------|------|------|
| SUMMER        | µmol L-1 | µmol L-1 | µmol L-1 | µmol L-1 | µmol L-1 | mg L-1 | mg L-1 |
| CAC_04_1      | 13.48 | 13.39 | 0.10 | 14.44 | 0.31 | 7.03 | 0.19 |
| CAC_04_6      | 14.36 | 12.43 | 0.35 | 21.48 | 1.52 | 4.76 | 0.17 |
| CAC_04_Bottom | 19.37 | 15.71 | 0.28 | 54.52 | 4.46 | 4.22 |
| CAC_05_1      | 14.25 | 14.18 | 0.09 | 15.45 | 0.27 | 6.63 | 0.20 |
| CAC_05_6      | 11.26 | 11.11 | 0.16 | 13.54 | 0.32 | 5.83 | 0.16 |
| CAC_05_12     | 15.49 | 9.78  | 0.62 | 16.02 | 1.11 | 3.32 | 0.14 |
| CAC_05_Bottom | 16.27 | 16.27 | 0.71 | 35.91 | 3.08 | 0.15 |
| CAC_06_1      | 13.91 | 13.76 | 0.14 | 14.85 | 0.28 | 8.14 | 0.19 |
| CAC_06_8      | 14.46 | 14.27 | 0.18 | 12.05 | 0.32 | 6.38 | 0.20 |
| CAC_06_15     | 14.73 | 13.00 | 0.32 | 15.41 | 0.56 | 3.14 | 0.18 |
| CAC_06_Bottom | 18.92 | 12.59 | 0.70 | 31.54 | 3.87 | 0.18 |
| CAC_07_1      | 15.40 | 15.31 | 1.07 | 16.75 | 0.29 | 7.73 | 0.21 |
| CAC_07_8      | 13.67 | 13.54 | 0.14 | 18.19 | 0.37 | 6.71 | 0.19 |
| CAC_07_18     | 14.46 | 8.28  | 0.14 | 37.90 | 4.10 | 9.76 | 0.12 |
| CAC_08_1      | 16.06 | 15.93 | 0.14 | 14.94 | 0.13 | 7.60 | 0.22 |
| CAC_08_10     | 17.01 | 14.47 | 0.20 | 25.29 | 0.30 | 6.64 | 0.20 |
| CAC_08_19     | 13.24 | 7.54  | 0.84 | 13.63 | 1.08 | 2.48 | 0.11 |
| CAC_08_Bottom | 14.45 | 8.99  | 0.82 | 31.42 | 4.01 | 0.13 |
| CAC_09_1      | 24.02 | 23.14 | 0.19 | 17.89 | 0.47 | 8.65 | 0.32 |
| CAC_09_10     | 15.84 | 14.98 | 0.15 | 17.95 | 0.28 | 6.59 | 0.21 |
| CAC_09_20     | 12.18 | 6.87  | 0.81 | 12.95 | 0.87 | 2.23 | 0.10 |
| CAC_09_Bottom | 13.14 | 7.91  | 0.83 | 28.97 | 3.39 | 0.11 |
| CAC_10_1      | 17.41 | 17.11 | 0.17 | 19.19 | 0.32 | 8.44 | 0.24 |
| CAC_10_10     | 15.67 | 13.46 | 0.25 | 10.86 | 0.29 | 6.55 | 0.19 |
| CAC_10_20     | 14.11 | 8.55  | 0.82 | 32.50 | 0.99 | 2.40 | 0.12 |
| CAC_10_Bottom | 14.94 | 11.25 | 0.60 | 68.50 | 3.88 | 0.16 |
| Sample Number | SPM    | Total Nitrogen | Total Carbon | C/N  |
|---------------|--------|----------------|--------------|------|
| SUMMER        | mg L-1 | [%]            | [%]          |      |
| CAC_04_1      | 4.25   | 1.16           | 10.17        | 8.76 |
| CAC_04_6      | 63.20  | 0.33           | 4.22         | 12.99|
| CAC_04_Bottom |        |                |              |      |
| CAC_05_1      | 2.78   | 1.35           | 11.45        | 8.48 |
| CAC_05_6      | 3.74   | 0.95           | 8.13         | 8.53 |
| CAC_05_12     | 14.80  | 0.33           | 4.19         | 12.68|
| CAC_05_Bottom |        |                |              |      |
| CAC_06_1      | 1.85   | 2.09           | 17.81        | 8.53 |
| CAC_06_8      | 3.04   | 1.08           | 8.82         | 8.18 |
| CAC_06_15     | 7.17   | 0.31           | 3.88         | 12.39|
| CAC_06_Bottom |        |                |              |      |
| CAC_07_1      | 1.40   | 2.89           | 23.99        | 8.31 |
| CAC_07_8      | 2.00   | 2.19           | 21.48        | 9.79 |
| CAC_07_18     | 11.29  | 0.18           | 2.45         | 13.33|
| CAC_07_Bottom |        |                |              |      |
| CAC_08_1      | 2.05   | 2.45           | 18.60        | 7.59 |
| CAC_08_10     | 2.32   | 1.25           | 10.86        | 8.70 |
| CAC_08_19     | 12.09  | 0.21           | 3.25         | 15.25|
| CAC_08_Bottom |        |                |              |      |
| CAC_09_1      | 1.42   | 3.12           | 21.99        | 7.05 |
| CAC_09_10     | 2.47   | 1.11           | 9.14         | 8.27 |
| CAC_09_20     | 5.84   | 0.33           | 4.00         | 12.16|
| CAC_09_Bottom |        |                |              |      |
| CAC_10_1      | 1.78   | 2.87           | 21.33        | 7.44 |
| CAC_10_10     | 2.67   | 1.45           | 11.66        | 8.03 |
| CAC_10_20     | 9.21   | 0.25           | 2.67         | 10.73|
| CAC_10_Bottom |        |                |              |      |
| Sample Number | TDN/TDP | DON/TDP | Nitrate / Phosphate | TN/TP | DOC/DON |
|---------------|---------|---------|---------------------|-------|---------|
| SUMMER        |         |         |                     |       |         |
| CAC_04_1      | 129.65  | 128.74  | 1.24                | 47.28 | 37.57   |
| CAC_04_6      | 40.66   | 35.19   | 5.95                | 14.16 | 27.38   |
| CAC_04_Bottom | 68.24   | 55.37   | 14.53               | 11.97 |         |
| CAC_05_1      | 152.95  | 152.23  | 0.46                | 57.06 | 33.4    |
| CAC_05_6      | 69.31   | 68.38   | 0.56                | 42.24 | 37.44   |
| CAC_05_12     | 25.08   | 15.83   | 9.64                | 14.47 | 24.22   |
| CAC_05_Bottom | 22.89   | 14.93   | 8.35                | 11.66 |         |
| CAC_06_1      | 100.30  | 99.22   | 1.13                | 53.77 | 42.26   |
| CAC_06_8      | 79.44   | 78.40   | 1.12                | 37.98 | 31.91   |
| CAC_06_15     | 46.24   | 40.82   | 7.24                | 27.30 | 18.71   |
| CAC_06_Bottom | 26.96   | 17.94   | 9.25                | 8.14  |         |
| CAC_07_1      | 14.36   | 14.27   | 0.42                | 56.83 | 36.08   |
| CAC_07_8      | 100.13  | 99.20   | 0.82                | 49.39 | 35.38   |
| CAC_07_18     | 102.71  | 58.81   | 7.86                | 9.25  | 84.19   |
| CAC_07_Bottom |         |         |                     |       |         |
| CAC_08_1      | 115.63  | 114.88  | 0.00                | 114.92| 34.07   |
| CAC_08_10     | 87.21   | 74.19   | 13.86               | 83.97 | 32.79   |
| CAC_08_19     | 15.83   | 9.02    | 6.98                | 12.66 | 23.48   |
| CAC_08_Bottom | 17.64   | 10.97   | 6.89                | 7.83  |         |
| CAC_09_1      | 124.57  | 119.99  | 14.62               | 38.23 | 26.72   |
| CAC_09_10     | 107.49  | 101.65  | 10.31               | 63.24 | 31.42   |
| CAC_09_20     | 44270   | 8.48    | 5.76                | 14.84 | 24.47   |
| CAC_09_Bottom | 15.84   | 9.53    | 6.41                | 8.55  |         |
| CAC_10_1      | 100.46  | 98.71   | 2.28                | 60.66 | 35.21   |
| CAC_10_10     | 62.90   | 54.01   | 12.90               | 37.68 | 34.76   |
| CAC_10_20     | 17.27   | 10.47   | 6.87                | 32.75 | 20.07   |
| CAC_10_Bottom | 24.80   | 18.68   | 6.18                | 17.65 |         |
| Sample Number | Longitude    | Latitude    | Date      | Bot. Depth | Temperature | Salinity |
|---------------|--------------|-------------|-----------|------------|-------------|----------|
| WINTER        |              |             |           | m          | °C          | PSU      |
| CAC19_01_2.5  | 129.2480173  | 72.5090386  | 2019-03-29| 11         | 0.08        | 0.21     |
| CAC19_01_6    | 129.2480173  | 72.5090386  | 2019-03-29| 11         | 0.09        | 0.21     |
| CAC19_01_11   | 129.2480173  | 72.5090386  | 2019-03-29| 11         | 0.05        | 0.21     |
| CAC19_02_2.5  | 129.5455126  | 72.5168283  | 2019-03-29| 3          | 0.06        | 0.20     |
| CAC19_03_3    | 129.8419953  | 72.5253607  | 2019-03-30| 4          | 0.05        | 0.21     |
| CAC19_04_3    | 129.8638871  | 72.5254943  | 2019-03-31| 3          | 0.10        | 0.21     |
| CAC19_23_2    | 129.6930193  | 72.5213603  | 2019-03-31| 3          | 0.13        | 0.21     |
| CAC19_A_2     | 129.1016438  | 72.5012794  | 2019-04-01| 12         | 0.10        | 0.21     |
| CAC19_A_7     | 129.1016438  | 72.5012794  | 2019-04-01| 12         | 0.06        | 0.21     |
| CAC19_A_11    | 129.1016438  | 72.5012794  | 2019-04-01| 12         | 0.05        | 0.21     |
| CAC19_B_2     | 128.9711000  | 72.4793812  | 2019-04-01| 6          | 0.11        | 0.21     |
| CAC19_B_5     | 128.9711000  | 72.4793812  | 2019-04-01| 6          | 0.02        | 0.21     |
| CAC19_C_2     | 128.8445192  | 72.455611   | 2019-04-02| 2          | 0.03        | 0.21     |
| CAC19_D_2     | 128.6944962  | 72.4615553  | 2019-04-02| 19         | 0.05        | 0.21     |
| CAC19_D_10    | 128.6944962  | 72.4615553  | 2019-04-02| 19         | 0.05        | 0.20     |
| CAC19_D_18    | 128.6944962  | 72.4615553  | 2019-04-02| 19         | 0.06        | 0.21     |
| CAC19_E_2.5   | 128.6297501  | 72.5019032  | 2019-04-03| 3          | 0.13        | 0.19     |
| CAC19_F_3     | 128.4921886  | 72.5187824  | 2019-04-03| 4          | 0.11        | 0.25     |
| CAC19_G_2.5   | 128.3532643  | 72.535431   | 2019-04-04| 9          | 0.18        | 0.21     |
| CAC19_G_7.5   | 128.3532643  | 72.535431   | 2019-04-04| 9          | 0.12        | 0.21     |
| CAC19_H_3     | 128.2384589  | 72.5640799  | 2019-04-04| 4          | 0.11        | 0.21     |
| Sample Number | Nitrite | Silicate | Phosphate | Ammonium | Nitrate |
|---------------|---------|----------|-----------|----------|---------|
| WINTER        | µmol L-1 | µmol L-1 | µmol L-1 | µmol L-1 | µmol L-1 |
| CAC19_01_2.5  | 0.15    | 100.93   | 0.10     | 0.89     | 12.58   |
| CAC19_01_6    | 0.11    | 112.99   | 0.10     | 0.98     | 12.68   |
| CAC19_01_11   | 0.12    | 109.18   | 0.13     | 1.63     | 12.30   |
| CAC19_02_2.5  | 0.09    | 120.26   | 0.11     | 0.89     | 9.59    |
| CAC19_03_3    | 0.13    | 82.94    | 0.08     | 0.95     | 11.25   |
| CAC19_04_3    | 0.16    | 118.32   | 0.10     | 0.82     | 10.70   |
| CAC19_23_2    | 0.18    | 111.85   | 0.10     | 0.77     | 10.39   |
| CAC19_A_2     | 0.10    | 104.95   | 0.11     | 1.01     | 9.84    |
| CAC19_A_7     | 0.10    | 107.54   | 0.11     | 0.90     | 10.37   |
| CAC19_A_11    | 0.08    | 104.46   | 0.09     | 0.95     | 10.64   |
| CAC19_B_2     | 0.15    | 99.13    | 0.09     | 1.04     | 10.17   |
| CAC19_B_5     | 0.09    | 107.29   | 0.09     | 0.91     | 10.46   |
| CAC19_C_2     | 0.13    | 115.05   | 0.10     | 0.96     | 10.01   |
| CAC19_D_2     | 0.13    | 111.24   | 0.10     | 0.95     | 8.83    |
| CAC19_D_10    | 0.09    | 115.16   | 0.10     | 0.82     | 8.69    |
| CAC19_D_18    | 0.12    | 103.12   | 0.08     | 0.91     | 10.25   |
| CAC19_E_2.5   | 0.11    | 95.32    | 0.09     | 0.80     | 8.79    |
| CAC19_F_3     | 0.30    | 142.42   | 0.12     | 14.63    | 7.79    |
| CAC19_G_2.5   | 0.12    | 91.47    | 0.09     | 1.52     | 9.87    |
| CAC19_G_7.5   | 0.12    | 104.51   | 0.09     | 0.96     | 8.97    |
| CAC19_H_3     | 0.08    | 119.38   | 0.10     | 0.91     | 7.59    |
| Sample Number | TDN   | DON   | TDP   | DOC   | DON   |
|---------------|-------|-------|-------|-------|-------|
|               | µmol L-1 | µmol L-1 | µmol L-1 | mg L-1 | mg L-1 |
| WINTER        |       |       |       |       |       |
| CAC19_01_2.5  | 24.19 | 10.58 | 0.16  | 6.09  | 0.15  |
| CAC19_01_6    | 24.15 | 10.38 | 0.15  | 6.13  | 0.15  |
| CAC19_01_11   | 27.95 | 13.90 | 0.20  | 6.28  | 0.19  |
| CAC19_02_2.5  | 21.21 | 10.65 | 0.17  | 7.30  | 0.15  |
| CAC19_03_3    | 25.12 | 12.78 | 0.14  | 6.02  | 0.18  |
| CAC19_04_3    | 23.53 | 11.85 | 0.16  | 6.61  | 0.17  |
| CAC19_23_2    | 22.86 | 11.52 | 0.13  | 6.11  | 0.16  |
| CAC19_0_2     | 23.95 | 13.01 | 0.16  | 6.01  | 0.18  |
| CAC19_0_7     | 22.58 | 11.21 | 0.15  | 6.17  | 0.16  |
| CAC19_0_11    | 24.38 | 12.71 | 0.15  | 5.94  | 0.18  |
| CAC19_0_2     | 23.70 | 12.34 | 0.23  | 6.12  | 0.17  |
| CAC19_0_5     | 24.60 | 13.14 | 0.15  | 5.91  | 0.18  |
| CAC19_0_2     | 24.49 | 13.39 | 0.15  | 6.13  | 0.19  |
| CAC19_0_2     | 22.86 | 12.95 | 0.16  | 6.55  | 0.18  |
| CAC19_0_10    | 20.15 | 10.55 | 0.14  | 5.97  | 0.15  |
| CAC19_0_18    | 22.60 | 11.32 | 0.15  | 6.72  | 0.16  |
| CAC19_0_25    | 21.19 | 11.50 | 0.14  | 5.82  | 0.16  |
| CAC19_0_3     | 34.39 | 11.67 | 0.22  | 8.54  | 0.16  |
| CAC19_0_25    | 23.58 | 12.08 | 0.15  | 6.05  | 0.17  |
| CAC19_0_7     | 20.83 | 10.80 | 0.17  | 6.12  | 0.15  |
| CAC19_0_3     | 21.20 | 12.62 | 0.14  | 6.02  | 0.18  |
| Sample Number | TDN/TDP | DON/TDP | Nitrate / Phosphate | DOC/DON |
|---------------|---------|---------|---------------------|---------|
| **WINTER**    |         |         |                     |         |
| CAC19_01_2.5  | 147.40  | 64.48   | 122.73              | 41.12   |
| CAC19_01_6    | 162.12  | 69.70   | 129.36              | 42.15   |
| CAC19_01_11   | 139.10  | 69.19   | 96.09               | 32.28   |
| CAC19_02_2.5  | 121.25  | 60.85   | 86.40               | 48.99   |
| CAC19_03_3    | 173.67  | 88.39   | 149.03              | 33.65   |
| CAC19_04_3    | 151.33  | 76.21   | 102.93              | 39.85   |
| CAC19_23_2    | 173.66  | 87.52   | 104.44              | 37.91   |
| CAC19_A_2     | 145.95  | 79.28   | 93.67               | 33.10   |
| CAC19_A_7     | 151.56  | 75.24   | 96.49               | 39.32   |
| CAC19_A_11    | 166.11  | 86.62   | 116.30              | 33.39   |
| CAC19_B_2     | 101.52  | 52.84   | 114.28              | 35.44   |
| CAC19_B_5     | 162.79  | 86.97   | 115.56              | 32.11   |
| CAC19_C_2     | 166.86  | 91.23   | 98.17               | 32.67   |
| CAC19_D_2     | 141.15  | 79.95   | 84.92               | 36.13   |
| CAC19_D_10    | 139.32  | 72.92   | 86.93               | 40.41   |
| CAC19_D_18    | 151.72  | 75.99   | 135.76              | 42.39   |
| CAC19_E_2.5   | 153.41  | 83.23   | 97.66               | 36.19   |
| CAC19_F_3     | 157.56  | 53.47   | 64.66               | 52.29   |
| CAC19_G_2.5   | 158.32  | 81.08   | 111.56              | 35.76   |
| CAC19_G_7.5   | 119.08  | 61.71   | 104.87              | 40.47   |
| CAC19_H_3     | 151.15  | 89.97   | 74.09               | 34.05   |