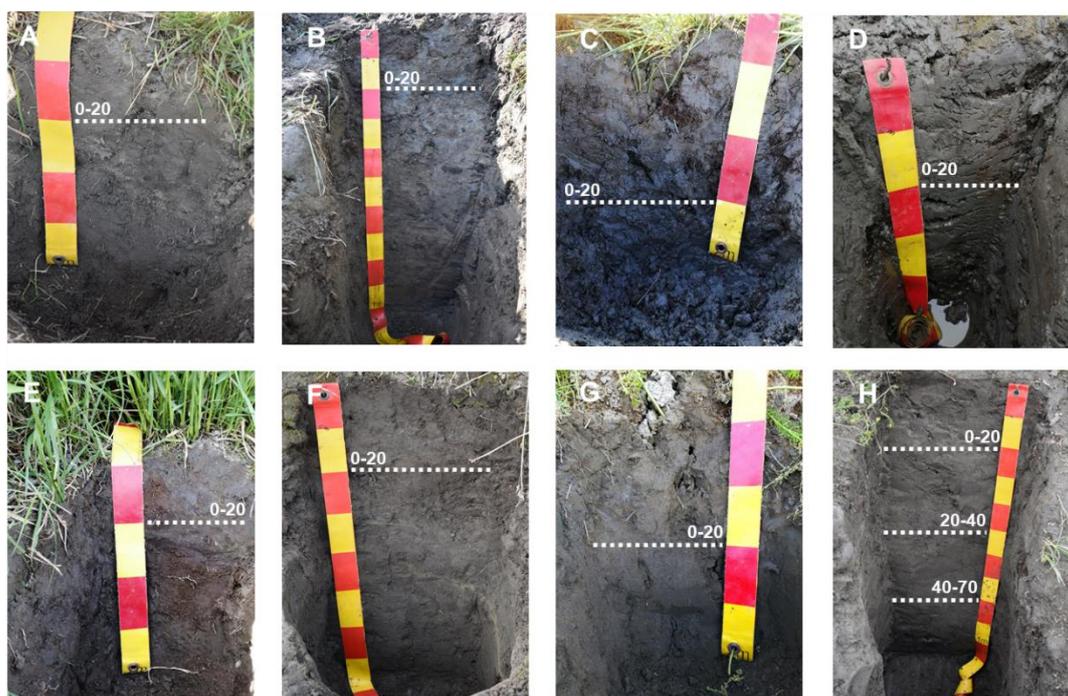


Supplementary Material



**Figure S1.** Studied field sites in 2019. (A): Revegetated slump floor SF3 V, (B): non-vegetated slump floor SF3 NV, (C): revegetated slump floor SF6 V, (D): non-vegetated slump floor SF6 NV, (E): revegetated thaw mound TM1 V, (F): non-vegetated thaw mound TM1 NV, (G): revegetated thaw mound TM2 V, (H): non-vegetated thaw mound TM2 NV. All vegetated sites are mainly covered by grasses and herbs and only SF6 NV is covered only by mosses.



**Figure S2.** Soil profiles with indication of analyzed depths (composite samples) of studied field sites in 2019. All soils were described as Protic Cryosols [26] (A): revegetated slump floor SF3 V, (B): non-vegetated slump floor SF3 NV, (C): revegetated slump floor SF6 V, (D): non-vegetated slump floor SF6 NV, (E): revegetated thaw mound TM1 V, (F): non-vegetated thaw mound TM1 NV, (G): revegetated thaw mound TM2 V, (H): non-vegetated thaw mound TM2 NV.

**Table S1.** Coordinates of the sampled soil profiles in July 2019. Samples were taken from revegetated (V) and non-vegetated (NV) slump floor (SF) and thaw mounds (TM) soils.

| Site   | Position             |
|--------|----------------------|
| SF3 V  | 72.3390 N 126.2921 E |
| SF3 NV |                      |
| SF6 V  | 72.3390 N 126.2914 E |
| SF6 NV |                      |
| TM1 V  | 72.3393 N 126.2929 E |
| TM1 NV |                      |
| TM2 V  | 72.3393 N 126.2919 E |
| TM2 NV |                      |

**Table S2.** Subsoil samples from the non-vegetated thaw mound site TM2 NV. Soil properties (water content (WC), water-filled pore space (WFPS), soil pH (pH), total carbon (TC), water extractable organic carbon (WEOC), carbon nitrogen ratio (C/N), phosphorus (P), delta  $^{15}\text{N}$  in bulk soil ( $\delta^{15}\text{N}$ ), dissolved organic nitrogen (DON), ammonium ( $\text{NH}_4^+$ ), nitrate ( $\text{NO}_3^-$ )), nitrogen transformation, as well as anaerobic GHG production rates and  $\text{CO}_2$  equivalents ( $\text{CO}_2\text{eq}$ ) are given for composite samples from 20–40 cm and 40–70 cm depth ( $n$  = number of replicates).

| Parameter   | TM2 NV<br>20–40 cm | TM2 NV<br>40–70 cm |
|-------------|--------------------|--------------------|
| $n$         | 3                  | 3                  |
| WC<br>(%)   | $17 \pm 0$         | $16 \pm 0$         |
| WFPS<br>(%) | n.d.               | $43 \pm 0$         |
| pH          | $8.1 \pm 0$        | $8.2 \pm 0$        |

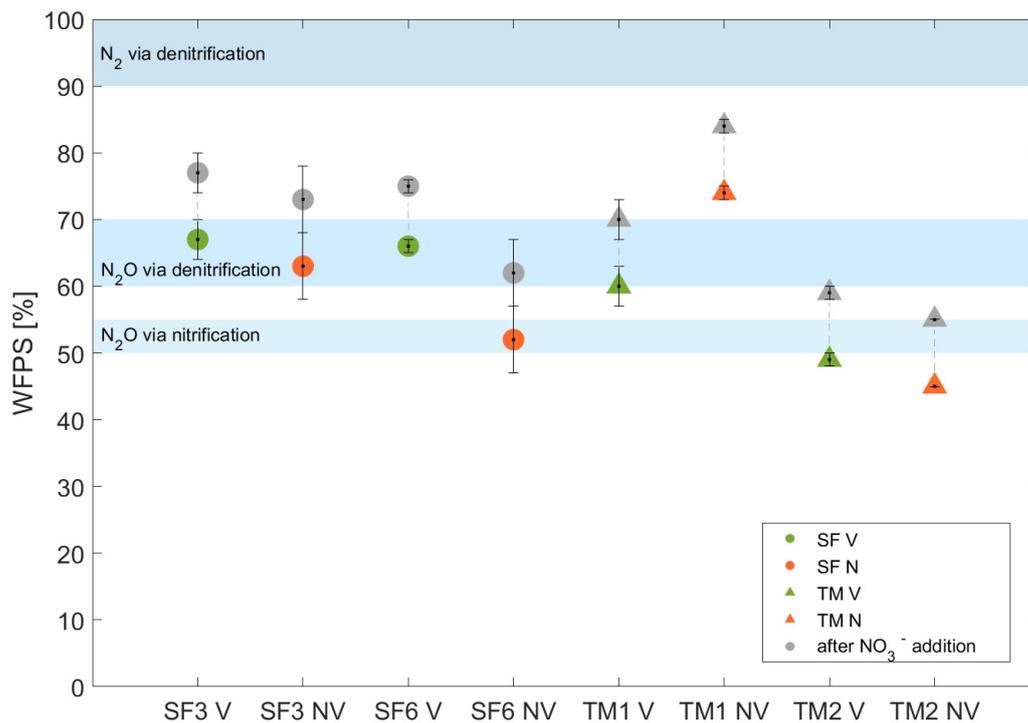
|  |                 |                |
|--|-----------------|----------------|
| TC<br>(%)  | 2.1 ± 0.0       | 1.6 ± 0.0      |
| WEOC<br>(µg C (g DW) <sup>-1</sup> )   | n.d.            | 83*            |
| C/N  | 13.7 ± 0.1      | 13.8 ± 0.4     |
| P<br>(µg P (g DW) <sup>-1</sup> )  | 8.5 ± 0.4       | 8.2 ± 0.0      |
| δ <sup>15</sup> N bulk<br>(‰)  | 2.73 ± 0.04     | 2.75 ± 0.02    |
| DON<br>(µg N (g DW) <sup>-1</sup> )  | 17.09 ± 1.32    | b.d.l          |
| NH <sub>4</sub> <sup>+</sup><br>(µg N (g DW) <sup>-1</sup> )                                   | 4.99 ± 0.10     | 3.47 ± 0.08    |
| NO <sub>3</sub> <sup>-</sup><br>(µg N (g DW) <sup>-1</sup> )                                   | 9.75 ± 0.23     | 5.23 ± 0.44    |
| Net ammonification<br>(ng N (g DW) <sup>-1</sup> d <sup>-1</sup> )                             | 0.00 ± 0.00     | 5.47 ± 2.51    |
| Net nitrification<br>(ng N (g DW) <sup>-1</sup> d <sup>-1</sup> )                              | 1044.02 ± 50.44 | 866.78 ± 14.48 |
| N <sub>2</sub> O<br>ng N <sub>2</sub> O-N (g DW) <sup>-1</sup> d <sup>-1</sup>                 | 63.66 ± 6.54    | 22.17 ± 10.48  |
| N <sub>2</sub> O with Nitrate<br>(ng N <sub>2</sub> O-N (g DW) <sup>-1</sup> d <sup>-1</sup> ) | 25.05 ± 11.06   | 29.73 ± 6.16   |
| CO <sub>2</sub><br>(µg CO <sub>2</sub> -C (g DW) <sup>-1</sup> d <sup>-1</sup> )               | 0.68 ± 0.08     | 0.82 ± 0.07    |
| CH <sub>4</sub><br>(ng CH <sub>4</sub> -C (g DW) <sup>-1</sup> d <sup>-1</sup> )               | 0.00 ± 0.00     | 0.00 ± 0.00    |
| CO <sub>2</sub> eq<br>(µg CO <sub>2</sub> eq-C (g DW) <sup>-1</sup> d <sup>-1</sup> )          | 19.65 ± 2.03    | 7.43 ± 3.19    |

Values (mean ± standard deviation), \* *n* = 1. n.d. = not determined. b.d.l. = below the detection limit.

**Table S3.** Dissolved nitrogen components for revegetated (V) and non-vegetated (NV) slump floor (SF) and thaw mound (TM) soils (*n* = number of replicates).

| Site   | <i>n</i> | DON<br>(µg N (g DW) <sup>-1</sup> d <sup>-1</sup> ) | NH <sub>4</sub> <sup>+</sup><br>(µg N (g DW) <sup>-1</sup> d <sup>-1</sup> ) | NO <sub>3</sub> <sup>-</sup><br>(µg N (g DW) <sup>-1</sup> d <sup>-1</sup> ) |
|--------|----------|---|--|--|
| SF3 V  | 3        | b.d.l.  | 0.06 ± 0.09  | 0.55 ± 0.78  |
| SF3 NV | 3        | 19.05 ± 4.22  | 6.31 ± 2.36  | 31.23 ± 6.20   |
| SF6 V  | 5        | 37.30 ± 5.42*                                       | 16.73 ± 2.66   | 0.53 ± 0.59  |
| SF6 NV | 2        | 37.54 ± 8.39  | 14.67 ± 1.16   | 0.73 ± 0.04  |
| TM1 V  | 3        | 9.30 ± 4.49   | 0.00 ± 0.00  | 81.64 ± 24.37  |
| TM1 NV | 3        | 4.17 ± 5.90   | 0.16 ± 0.20  | 7.05 ± 6.26  |
| TM2 V  | 3        | b.d.l.  | 0.00 ± 0.00  | 11.05 ± 1.16   |
| TM2 NV | 3        | 3.06 ± 4.32   | 1.34 ± 0.45  | 9.44 ± 1.61  |

Values (mean ± standard deviation), \* *n* = 4. b.d.l. = below the detection limit.



**Figure S3.** Water-filled pore space (WFPS) for revegetated (green) and non-vegetated (orange) sites. With substrate addition (152 mM nitrate) the WFPS increased about 10% (grey). Blue bars indicate the optimal WFPS for N<sub>2</sub>O release via nitrification (50–55%), denitrification (60–70%), as well N<sub>2</sub> loss via denitrification (>90%) according to Voigt et al. [7].

**Table S4.** N<sub>2</sub>O production rates from the anaerobic incubation (4 °C) without and with nitrate addition (152 mM) for revegetated (V) and non-vegetated (N) slump floor (SF) and thaw mound (TM) soils ( $n$  = number of replicates).

| Site   | $n$ | N <sub>2</sub> O<br>(ng N <sub>2</sub> O-N (g DW) <sup>-1</sup> d <sup>-1</sup> ) | N <sub>2</sub> O with Nitrate<br>(ng N <sub>2</sub> O-N (g DW) <sup>-1</sup> d <sup>-1</sup> ) |
|--------|-----|---|--|
| SF3 V  | 3   | 0.00 ± 0.00   | 2277.65 ± 1374.37  |
| SF3 NV | 3   | 95.43 ± 43.21   | 63.04 ± 30.14  |
| SF6 V  | 5   | 0.00 ± 0.00   | 3,312.74 ± 426.27  |
| SF6 NV | 2   | 0.10 ± 0.10   | 1827.23 ± 1307.69  |
| TM1 V  | 3   | 216.63 ± 158.25   | 91.78 ± 107.96   |
| TM1 NV | 3   | 0.00 ± 0.00   | 40.14 ± 49.89  |
| TM2 V  | 3   | 27.85 ± 27.75   | 16.33 ± 1.05   |
| TM2 NV | 3   | 25.16 ± 1.30  | 22.66 ± 6.05   |

Values (mean ± standard deviation).

**Table S5.** CO<sub>2</sub> equivalents (CO<sub>2</sub>eq) calculated from the anaerobic incubation without and with nitrate addition (152 mM) for revegetated (V) and non-vegetated (N) slump floor (SF) and thaw mound (TM) soils ( $n$  = number of replicates).

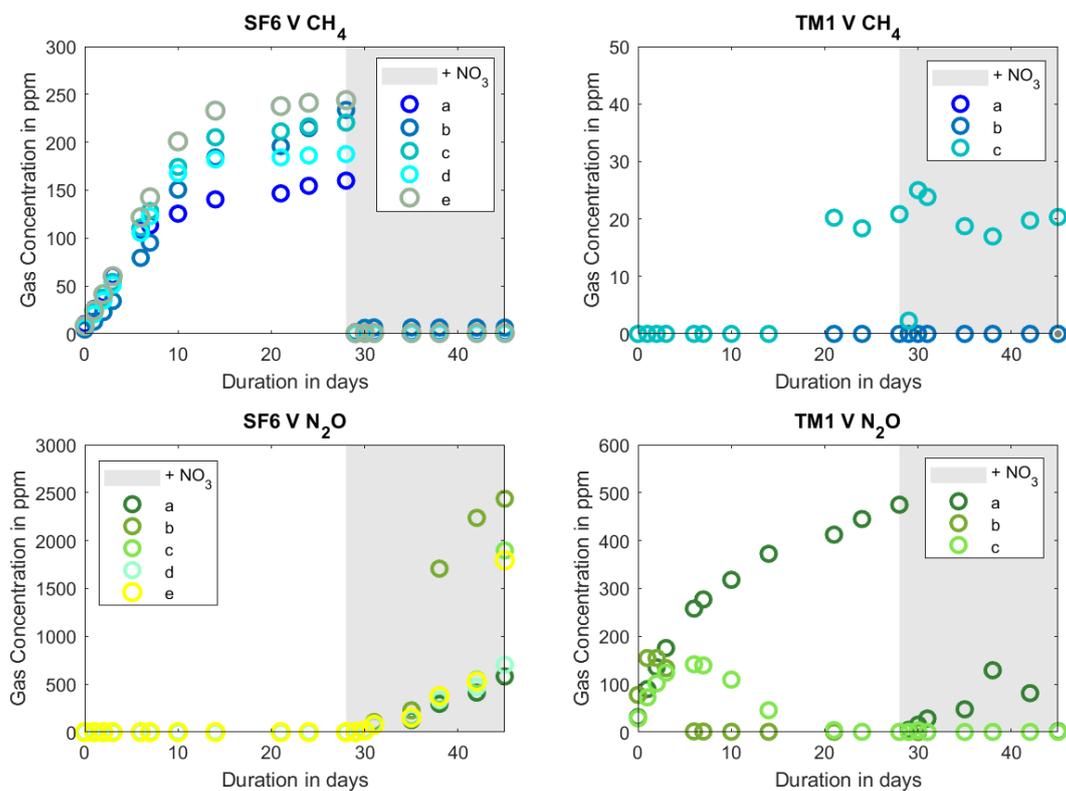
| Site   | $n$ | CO <sub>2</sub> eq<br>(μg CO <sub>2</sub> eq-C (g DW) <sup>-1</sup> d <sup>-1</sup> ) | CO <sub>2</sub> eq with Nitrate<br>(μg CO <sub>2</sub> eq-C (g DW) <sup>-1</sup> d <sup>-1</sup> ) |
|--------|-----|---|--|
| SF3 V  | 3   | 6.51 ± 3.00   | 681.78 ± 410.59  |
| SF3 NV | 3   | 29.43 ± 13.20   | 19.56 ± 9.24   |
| SF6 V  | 5   | 9.29 ± 1.73   | 990.09 ± 127.85  |
| SF6 NV | 2   | 3.27 ± 1.72   | 546.97 ± 389.94  |
| TM1 V  | 3   | 65.71 ± 47.03   | 29.11 ± 31.60  |

|        |   |             |               |
|--------|---|-------------|---------------|
| TM1 NV | 3 | 2.56 ± 0.88 | 15.66 ± 16.03 |
| TM2 V  | 3 | 8.56 ± 8.26 | 5.03 ± 0.32   |
| TM2 NV | 3 | 8.02 ± 0.27 | 7.42 ± 2.02   |

Values (mean ± standard deviation).

**Table S6.** Dates of *in-situ* N<sub>2</sub>O measurements in 2019. Measurements were made only at non-vegetated (NV) slump floor (SF) and thaw mound (TM) sites. *In-situ* N<sub>2</sub>O fluxes are given in Table 4.

| Site  | Date of Measurements   |
|-------|------------------------|
| SF3 V | n.d.                   |
| SF3 N | 10, 18, 23-07-2019     |
| SF6 V | n.d.                   |
| SF6 N | 10, 19, 23-07-2019     |
| TM1 V | n.d.                   |
| TM1 N | 10, 23-07-2019         |
| TM2 V | n.d.                   |
| TM2 N | 11, 17, 18, 23-07-2019 |



**Figure S4.** Cumulative CH<sub>4</sub> (above) and N<sub>2</sub>O (below) headspace gas concentration for the selective sites SF6 V (left) and TM1 V. The gray space indicates the period where the flasks were flushed with N<sub>2</sub> and subsequently nitrate was added. Left: Samples produced directly at the beginning CH<sub>4</sub> till flasks were flushed and N<sub>2</sub>O production started. Right: There was no CH<sub>4</sub> production but in replicate c, CH<sub>4</sub> production started after N<sub>2</sub>O concentration declined in the headspace.