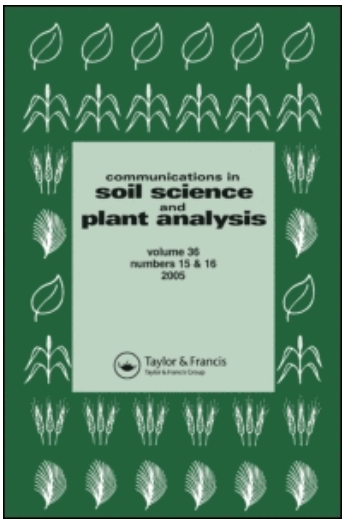

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Nitrous Oxide Production and Consumption Potential in an Agricultural and a Forest Soil

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Abstract: Both a laboratory incubation experiment using soils from an agricultural field and a forest and field measurements at the same locations were conducted to determine nitrous oxide (N_2O) production and consumption (reduction) potentials using the acetylene (C_2H_2) inhibition technique. Results from the laboratory experiment show that the agricultural soil had a stronger N_2O reduction potential than the forest soil, as indicated by the N_2O/N_2 ratio in denitrification products. Without C_2H_2 inhibition, N_2O could reach a maximum concentration of 51 and 296 ppmv in headspace of the agricultural and forest soil slurries, respectively. Addition of glucose decreased the maximum N_2O concentration to 22 ppmv in headspace of the agricultural soil slurries, but increased to 520 ppmv in the forest soil slurries. Addition of exogenous N_2O did not change such N_2O accumulation maxima during the incubations. The field measurements show that average N_2O emission rates were 0.56 and 0.59 kg N ha^{-1} in the agricultural field and forest, respectively. When C_2H_2 was provided in the field measurements, N_2O emission rates from the agricultural field and forest increased by 38 and 51%, respectively. Nitrous oxide consumption under elevated N_2O condition (about 300 ppmv) was found in all five agricultural field measurements, but only in three of the six forest measurements under the same conditions. Field measurements agreed with the laboratory experiment that N_2O reduction activity, which plays a critical role in abating N_2O emissions from soils, largely depended on soil characteristics associated with land use.

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INTRODUCTION

Nitrous oxide (N_2O) is a trace gas in the atmosphere contributing to the global greenhouse effect and partially responsible for the catalytic destruction of stratospheric ozone (Crutzen 1981; Weiss 1981; Dickinson and Cicerone 1986). Soils are a major source of atmospheric N_2O, but the source strength largely varies primarily depending on vegetation, nitrogen (N) input, organic-matter availability, and regional climate. The abundance of N_2O in the atmosphere is only 0.3 ppmv, but its residence time is about 150 years (Kim and Craig 1993), much longer than the other two important greenhouse gases, carbon dioxide (CO_2) and methane (CH_4). This indicates a relatively slow removal of N_2O from the atmospheric stock. The only identified sink of N_2O is the photolysis in the stratosphere at 7–13 Tg N y^{-1} (IPCC 1994). There is some evidence in field measurements that soils can consume ambient atmospheric N_2O (Bremner, Robbins, and Blackmer 1980; Ryden 1981; Donoso, Santana, and Sanhueza 1993), but there is no sufficient data to evaluate the global capacity of N_2O removal by soils.

Both nitrification and denitrification contribute to N_2O production in soils. In addition, N_2O can be further reduced to N_2 in a complete denitrification, which is the only known biological mechanism of N_2O consumption. Regardless of whether soil N_2O comes from nitrification or denitrification processes, the N_2O reduction activity plays a critical role in the quantities of N_2O emission from soils. The activity of N_2O reduction may be regulated by N_2O reduction enzyme and soil characteristics such as redox status, pH, and the availability of organic matter. Increase of N_2O emission from soils to the atmosphere probably is due mainly to increasing anthropogenic N input into soils. Weakening N_2O reduction activity due to land-use change and management practices is also responsible for the increasing N_2O emission from soils. In this study, N_2O production and reduction potentials were determined from both a laboratory incubation experiment and field measurements at two study sites with different land uses.

MATERIALS AND METHODS

Study sites for the soil samplings of laboratory experiment and for the field measurements were an agricultural field and a mixed beech and spruce forest in Denmark. The agricultural field was planted with barley

1 week before the first field measurement in May. The agricultural field was fertilized once a year during sowing of barley at a rate of 80 kg N ha^{-1} with nitrate (NO_3^-)-N/ammonium (NH_4^+)-N ratio 5.5:7.0. Surface soils (0–20 cm) from both the agricultural field and forest were taken in August for the laboratory experiment. Description of the two study sites and major soil characteristics are summarized in Table 1.

Laboratory Incubation Study

The sample soils from the two study sites were air dried, sieved (2 mm), thoroughly mixed, and stored at 5 °C before the laboratory incubation experiment. Major soil characteristics of the two sample soils were analyzed and summarized in Table 1. Water contents of the air-dried soils were 9.6% and 1.2% for the forest soil and agricultural soil, respectively.

Soil slurry was established by putting 20 g air-dried soil and 20 mL distilled water into a 120-mL glass flask. In an anaerobic incubation, 10% (in volume) of C_2H_2 can effectively inhibit N_2O reduction activity, making N_2O the end product of denitrification (Tiedje, Simkins, and Groffman 1989). For each soil, 24 soil slurries were established and divided into two groups: control and glucose addition. Each group had four treatments: no addition of C_2H_2 or N_2O, C_2H_2 addition, N_2O addition, and combined C_2H_2 and N_2O addition. Each of these eight different treatments had three replicates. Glucose, as an electron donor for denitrification, was provided by 1 mL solution with final addition of 126 μg carbon (C) g^{-1} soil. Then each flask was sealed with a rubber stopper, evacuated for 5 min, and refilled with pure N at 1 atmospheric pressure to ensure an anaerobic incubation environment. Pure C_2H_2 was injected to replace 10 mL of

Table 1. Description of the study sites for the field measurement and major characteristics of the soils for the laboratory incubation experiment

Parameter	Agricultural field	Forest
Vegetation	Barley	Beech and Spruce
Location	Roskilde, N55° 38.74′, E12° 04.88′	Sorø, N55° 26.42′, E11° 34.07′
pH	6.84 (in H_2O), 6.42 (in KCl)	6.34 (in H_2O), 4.87 (in KCl)
Ammonium (μg N g^{-1} soil)	0.72	5.20
Nitrate (μg N g^{-1} soil)	3.66	13.88
Total C (%)	1.30	1.69
Total N (%)	0.19	0.17
C/N ratio	6.84	9.94
Bulk density	1.79 (0.35)	1.10 (0.20)

Note. Results for bulk densities are means of duplicate measurements with standard deviations in parentheses.

headspace of the corresponding flasks. Exogenous N_2O was injected by 1 mL of 1% (in volume) N_2O for the N_2O addition treatment (providing about 100 ppmv N_2O in the headspace). All the flasks were incubated at 12 °C (close to the average temperature in the fields during the study period) for 1 week with daily gas samplings.

Field Study Sites and Measurements

Field measurements were conducted once a month from April to October, which was the season with soil temperature warmer than 5 °C (commonly referred as biological zero, above which most biological reactions significantly take place). An in situ soil core method was used with a PVC tube (23 cm in height and 10 cm in diameter) inserted into 10 cm of the soil depth. Each tube had a removable covering lid with a rubber stopper for gas sampling. To minimize the interference of setting up soil cores, which disturbed soil profiles, on soil gas fluxes, a new set of PVC tubes were set up in the fields 1 month prior to the sampling date to allow time for equilibrium. Four treatments with 8 replicates (32 tubes needed) were applied to each study site, including control (with neither C_2H_2 nor N_2O), C_2H_2 addition, N_2O addition, and combined C_2H_2 and N_2O addition. After covering the lid and rubber stopper, 60 mL pure C_2H_2 was injected into the headspace of the corresponding tubes. This amount of C_2H_2 represents approximately 10% of the total tube volume of the soil core, making sufficient C_2H_2 diffuse into soil pore space to inhibit N_2O reduction in the soils.

Nitrous oxide addition was applied by injecting 2 mL of 5% (in volume) N_2O through the rubber stopper. This was equivalent to about 300 ppmv of N_2O in the tube headspace. Each measurement lasted for 4 h with hourly sampling of 4.5 mL using a syringe through the rubber stopper. The gas sample was immediately transferred into a 3.0-mL venoject vial (Terumo Europe, Belgium) for later analysis of N_2O and CO_2 by gas chromatography. During each field measurement, surface soils (0–20 cm) were sampled for analysis of pH, concentrations of ammonium and nitrate, and water content. In addition, soil temperature at the 10-cm depth was recorded. After gas sampling, the lid was uncovered, and the height of PVC tube above soil surface was recorded to calculate headspace for each soil core. Then all the PVC tubes were removed and set-up again in an adjacent location preparing for next sampling event.

Calculation of N_2O Reduction Rate in the Field Measurement

Both nitrification and denitrification contribute to N_2O emissions in fields. Nitrous oxide reduction rate cannot be directly determined by the

difference between N_2O emission in control and in C_2H_2-inhibited treatment in fields, because nitrification activity is also inhibited when C_2H_2 is applied to inhibit N_2O reduction activity. We assume that exogenous N_2O addition would not affect original nitrification and denitrification activities (including original N_2O reduction activity in denitrification) in the fields. Total N_2O reduction rate under such elevated N_2O conditions will be increased because of the additional substrate for N_2O reduction activity. Nitrous oxide reduction rates under elevated N_2O conditions can be estimated as follows:

$$\text{Control}: \ N_2O(C) = P(Nit) + P(Den) - R(Nit + Den) \tag{1}$$

$$C_2H_2 \text{ addition}: \ N_2O(A) = P(Den) \tag{2}$$

$$N_2O \text{ addition}: N_2O(N) = N_2O(E) + P(Nit) + P(Den) - R(E) - R(Nit + Den) \tag{3}$$

$$N_2O \text{ and } C_2H_2 \text{ addition}: \ N_2O(NA) = N_2O(E) + P(Den) \tag{4}$$

$N_2O(C)$, $N_2O(A)$, $N_2O(N)$, and $N_2O(NA)$ represent N_2O dynamics from the four treatments; P(Nit) and P(Den) represent N_2O produced from nitrification and denitrification, respectively; $N_2O(E)$ represents the amount of exogenous N_2O addition; R(Nit+Den) represents reduction of N_2O produced from nitrification and denitrification; and R(E) represents reduction of N_2O from the added N_2O.

It is worthwhile to mention that both R(Nit+Den) and R(E) come from the last step of soil denitrification activity.

By Eq.(3)−Eq.(1),

$$N_2O(N) - N_2O(C) = N_2O(E) - R(E) \tag{5}$$

By Eq.(4)−Eq.(2),

$$N_2O(NA) - N_2O(A) = N_2O(E) \tag{6}$$

Therefore, by Eq.(6)−Eq.(5),

$$R(E) = [N_2O(NA) - N_2O(A)] - [N_2O(E) - N_2O(C)] \tag{7}$$

Ambient atmospheric N_2O is in a trace amount (0.3 ppmv) and is ignored in the previous calculations. Ignorance of such ambient N_2O was valid, because the N_2O emission rate was determined by regression of N_2O concentration changes during the 4-h measurement. We estimated N_2O reduction rates under elevated N_2O conditions according to Eq. (7). This N_2O reduction rate is independent of the amount of N_2O production from nitrification and denitrification as seen from the calculation. The calculated N_2O reduction rate [R(E)] exclusively depends on the amount of added N_2O and is assumed to follow first-order kinetics with N_2O concentration. Even though the same amount of N_2O was added, actual N_2O concentrations in soil cores were different because of spatial variations of the field conditions. Therefore, we report the N_2O reduction rates as N_2O reduction constants (N_2O reduction rate at 1 ppmv N_2O level) for each measurement.

Sample Analysis and Data Calculation

Gas samples were analyzed in a Hewlett-Packard 5890 gas chromatograph with an electron capture detector (ECD) to determine N_2O and CO_2 concentrations. Soil samples were extracted with 0.1 N KCl solution (weight ratio 1:1) for analysis of NH_4^+ and NO_3^- concentrations after filtration (0.45 μm) by a flow-injection N analysis system (Aquatec, Sweden) and pH on a pH meter 28 (Radiometer Copenhagen). Total C and N were analyzed by a CN analyzer. The amount of N_2O dissolved in the water phase of soil slurries was considered by taking Bunsen coefficient 0.84 at 12 °C (Weiss and Price 1980). N_2O concentration (ppmv) in slurry headspace can be estimated by the following formula: N_2O concentration (ppmv) = N_2O concentration ($\mu g\,N\,g^{-1}$ soil) $\times$ 160. Accumulation rates of N_2O (and CO_2 for the field measurement) were calculated by linear regressions of the first 2-day measurements for the laboratory experiment and of the 4-h measurements for the field study. Field N_2O reduction constant was calculated by Eq. (7) and then divided by average N_2O concentration added. Soil bulk density was determined by measuring dry weight of the soil in known volume. Soil water content was determined by drying the soil samples at 105 °C to constant weight. All data were reported in oven-dry weight of the soils. Water-filled pore space (WFPS) was calculated as WFPS = (gravimetric water content $\times$ soil bulk density) / total soil porosity, where total soil porosity = 1−(soil bulk density / 2.65), assuming particle density of the soil is 2.65. Statistical analysis was conducted using SAS software, version 9.1 (SAS Institute Inc., Cary, N.C., USA). The significance level was chosen at $\alpha = 0.05$.

RESULTS AND DISCUSSION

N_2O Production and Reduction Potentials in the Laboratory Study

Denitrification is the major source of N_2O production when soils are incubated in an anaerobic environment. When N_2O reduction to N_2 in denitrification was inhibited by C_2H_2, the two soils showed a similar N_2O production potential (Table 2), even though nitrate concentration in the forest soil was about four times higher than in the agricultural soil (Table 1). Denitrification activity in the forest soil was apparently limited by available organic matter, because glucose addition immediately enhanced the N_2O production by 74%. In contrast, glucose addition only increased denitrification activity by 6% in the agricultural soil. Without C_2H_2 inhibition, accumulation of N_2O is the net result of N_2O production and reduction. Despite similar N_2O production rate in C_2H_2 inhibition treatment, N_2O production rate without C_2H_2 inhibition in the agricultural soil slurries was only 19% of that in the forest soil slurries, and this percentage became 2% when glucose was added. The results suggest that the agricultural soil had a stronger N_2O reduction potential than the forest soil, as indicated by the N_2O/N_2 ratio (Table 2). Overall, addition of organic matter (such as glucose) favored N_2O production (N_2O/N_2 ratio increase) in electron-limited soils (such as the forest soil), but favored N_2O reduction (N_2O/N_2 ratio decrease) in non-electron-limited soils (such as the agricultural soil).

Without C_2H_2 inhibition of N_2O reduction, kinetics of N_2O concentration in the two soil slurries showed a remarkably different pattern during the incubation where both N_2O production and reduction activities existed (Figure 1). In the agricultural soil slurries, N_2O concentration in the headspace of the glucose-added treatment was consistently lower than the control. In the N_2O-addition treatment, there was almost no change of N_2O concentration in the headspace of the agricultural soil slurries during the incubation. When both N_2O and glucose were added, N_2O concentration in the headspace showed a continuous decreasing trend in the agricultural soil slurries. In the forest soil slurries, glucose addition increased N_2O concentration in the headspace more than the control, and there was little difference in N_2O accumulation pattern between treatments with or without N_2O addition. Maximum N_2O concentration in the agricultural soil slurries was 0.32 and 0.14 $\mu g\,N\,g^{-1}$ soil (equivalent to 51 and 22 ppmv in the headspace) for the control and glucose addition treatment, respectively. Maximum N_2O concentrations in the forest soil slurries were 1.85 and 3.25 $\mu g\,N\,g^{-1}$ soil (equivalent to 296 and 520 ppmv in the headspace), respectively, for the control and glucose addition treatment. When N_2O reaches its maximum concentration in soil slurries, it represents equilibrium between

Table 2. N_2O productions ($\mu g\,N\,kg^{-1}$ soil h^{-1}) in the laboratory incubation experiment

	Without C_2H_2		With C_2H_2		N_2O/N_2 ratio	
Parameter	Agricultural	Forest	Agricultural	Forest	Agricultural	Forest
Control	5.48 (0.56)	28.60 (1.23)	45.46 (3.49)[a]	48.83 (7.34)	0.14	1.41
Glucose	1.61 (0.09)	75.03 (8.85)	48.17 (6.51)[a]	84.95 (8.92)	0.03	7.56

Notes. Results from N_2O addition treatments are not included. Data represent means with standard deviations in parentheses (n = 3). Data in the same column are significantly different ($p < 0.05$, n = 3), except those labeled with the same letter.

N_2O/N_2 ratios were calculated by the formula N_2O/N_2 ratio = N_2O production without C_2H_2/(N_2O production with C_2H_2 − N_2O production without C_2H_2).

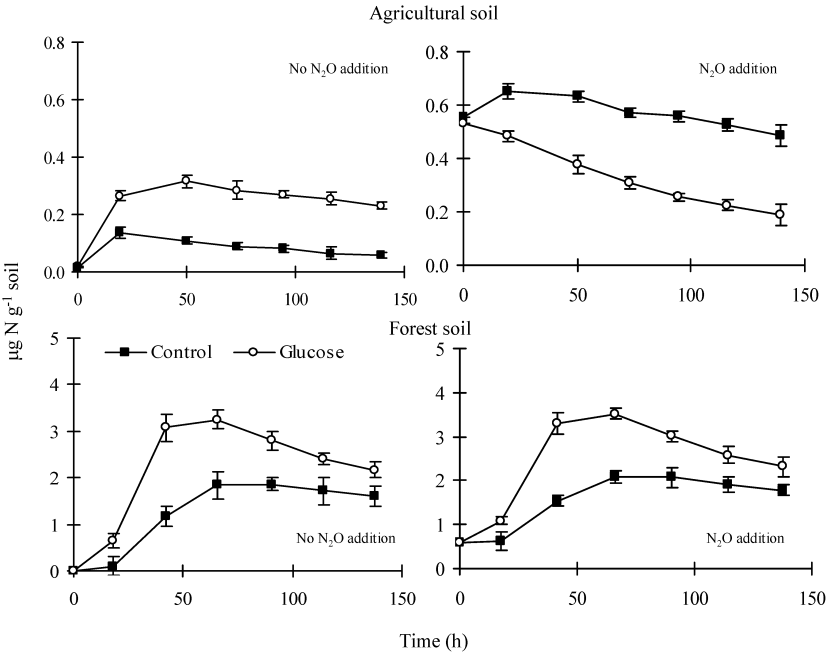

Figure 1. Dynamics of N_2O concentrations in the laboratory incubation experiment. Only results from treatments without C_2H_2 are shown. Bars represent standard deviations of the means (n = 3).

N_2O production and reduction, which is a soil-specific characteristic. Consequently, when exogenous N_2O was added, N_2O accumulation showed a decreasing trend in the agricultural soil slurries (N_2O added > maximum N_2O concentration), but an increasing trend in the forest soil slurries (N_2O added < maximum N_2O concentration).

Glucose addition decreased the N_2O accumulation in the incubated agricultural soil but increased the N_2O accumulation in the incubated forest soil (Table 2 and Figure 1). Electron competition exists between nitrate and N_2O reduction processes, and in most cases nitrate has a greater advantage to obtain electrons than N_2O. Higher concentration of nitrate in the forest soil than the agricultural soil (Table 1) partially explained more accumulation of N_2O in the forest soil slurries than in the agricultural soil slurries during the incubation. In a prolonged incubation without C_2H_2 inhibition, N_2O accumulation started to decrease after reaching a maximum when nitrate concentration was substantially decreased and N_2O reduction became a dominant process.

Soil CO_2 Production in the Fields

Unlike in soil slurries where mainly anaerobic soil respiration occurs, both aerobic and anaerobic biological respiration processes contribute to CO_2 production in fields. The CO_2 production rate in the forest was about three times higher than in the agricultural field (Table 3). Effect of C_2H_2 addition on soil CO_2 production was statistically insignificant for both study sites. Exogenous N_2O addition reduced soil CO_2 production by 11% and 55% in the agricultural field and in the forest, respectively. Fungal activities and plant root respiration has been reported to account for a large portion of CO_2 production in forest soils (Behera, Joshi, and Pati 1990). The mechanism of substantial decrease in soil CO_2 production by N_2O addition remains unknown and deserves future investigation. Reducing CO_2 production by N_2O addition was also found in the laboratory incubation experiment but was not as significant as in the field measurement (data not shown).

Field N_2O Emission and Consumption

Seasonal N_2O fluxes from the two study sites under different treatments are summarized in Figure 2, and soil conditions at each field measurement are included in Figure 3. Average soil temperature was 13.6 and 11.0 °C for the agricultural field and forest, respectively. The two study sites functioned as a source of N_2O emission in natural condition, and no consumption of ambient atmospheric N_2O was observed during the study period. Both nitrification and denitrification were associated with N_2O production and emission in fields because of co-existence of aerobic and anaerobic environment. Inhibition of nitrification activity (and N_2O production from the nitrification process) by C_2H_2 addition was probably the major cause for the observed lower N_2O emissions in some of the C_2H_2-inhibited measurements (Figure 2).

Table 3. Field measurements of CO_2 productions ($mg\,C\,m^{-2}\,h^{-1}$)

Treatment	Agricultural field	Forest
Control	32.70 (11.46) [a]	93.95 (62.11) [a]
C_2H_2	36.37 (9.69) [a]	90.91 (62.79) [a]
N_2O	29.20 (7.28) [a]	42.41 (16.04) [b]
C_2H_2+N_2O	26.82 (9.35) [a]	42.20(18.23) [b]

Notes. Data represent means with standard deviations in parentheses ($n = 8$). Significant ($p < 0.05$) and insignificant ($p > 0.05$) difference of the means are denoted by different and same letters, respectively.

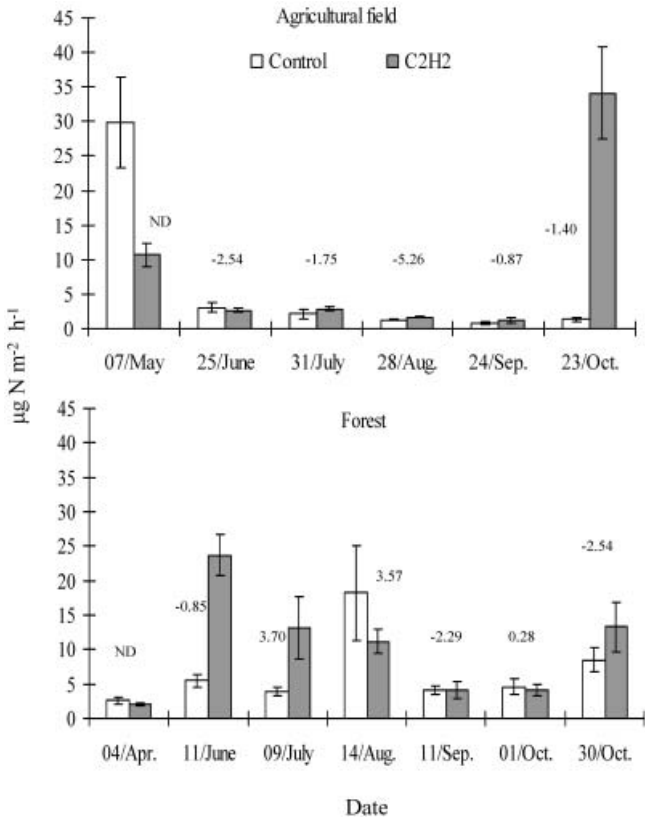

Figure 2. Field measurement of N_2O fluxes in the agricultural field and the forest. N_2O consumption rates were expressed as the rate constants and labeled in the figure. Negatively labeled data indicate net N_2O consumption. Positively labeled data indicate net N_2O emissions. N_2O consumption capacities were not determined in the first field measurement.

The average N_2O emission rates in the agricultural field were 6.41 ± 11.54 and 8.86 ± 12.85 $\mu g\,N\,m^{-2}\,h^{-1}$ for the control and C_2H_2-inhibited treatment, respectively. If mean N_2O flux remained the same throughout the year, annual N_2O-N loss from the agricultural field was $0.56 \pm 1.00\,kg\,N\,ha^{-1}$ (in control), equivalent to $0.7 \pm 1.3\%$ of the fertilizer N applied. Nitrogen loss as N_2O was estimated between 0.5 and 2.0% of fertilizer N worldwide (OECD/OCDE 1991; Conrad, Seiler, and Bunse 1983). In the agricultural soil, the highest nitrate and ammonium concentrations were found in May, mainly because of spring fertilization and possible minor contribution from soil mineralization during the winter. Nitrous oxide emissions in natural condition from the agricultural field were strongly correlated with the soil ammonium

concentration ($R^2 = 0.99$, $P = 0.0005$, $n = 5$) and nitrate concentration ($R^2 = 0.82$, $P = 0.089$, $n = 5$), but such correlations were poor for the N_2O emissions from the C_2H_2-added field (Figures 2 and 3). In the agricultural field, the highest N_2O emission was found in the last measurement with C_2H_2 addition treatment (Figure 2). Denitrification probably accounted for a major portion of this N_2O emission, because higher water content (WFPS = 0.86) created anaerobic soil conditions favorable for denitrification to occur (Hutchinson and Davidson 1993). However, most of the N_2O produced in the last measurement was consumed before release to the atmosphere, as evidenced by the small N_2O emission in natural conditions (Figures 2 and 3). In the forest, N_2O fluxes ($n = 8$) were found to be generally temperature dependent (control: $R^2 = 0.70$, $P = 0.05$; C_2H_2: $R^2 = 0.50$, $P = 0.20$). No significant correlations between N_2O emission rates and soil ammonium and nitrate concentrations were found. The average N_2O emission rates in the forest were 6.79 ± 4.97 $\mu g\,N\,m^{-2}\,h^{-1}$ for the control and 10.23 ± 6.99 $\mu g\,N\,m^{-2}\,h^{-1}$ for the C_2H_2 addition treatment, respectively. Thus, annual N_2O loss from the forest was $0.59 \pm 0.43\,kg\,N\,ha^{-1}$ (in control).

When exogenous N_2O was added into the soil cores at the two study sites, N_2O concentration in the headspace was continuously decreasing during the 4-h measurement for both N_2O and combined N_2O and C_2H_2 treatment. This was mainly due to N_2O diffusion into soil pore space during the measurement period. Under such an elevated N_2O condition (about 300 ppmv), N_2O reduction activity could be significant if soil environment and/or microenvironment of soil aggregates were favorable for denitrification. The calculated N_2O reduction rate constant [according to Eq. (7) and divided by the average concentration of N_2O added] represents N_2O reduction potential under 1 ppmv N_2O condition. Nitrous oxide consumption under the elevated N_2O condition was found in all five agricultural field measurements, but only in three of the six forest measurements under the same conditions (Figure 2). No significant correlation between N_2O reduction potentials and measured soil parameters in the two study fields was found. Observations on consumption of atmospheric N_2O have been reported from field measurements of cultivated soils (Bremner, Robbins, and Blackmer 1980; Yu, Chen, and Yang 1995; Mahmood, Malik, and Shamsi 1998), grasslands (Cicerone et al. 1978; Ryden 1981; Donoso, Santana, and Sanhueza 1993), and tropical soils (Keller et al. 1986; Matson and Vitousek 1987). Major factors regulating N_2O reduction potential in soils may include N_2O reduction enzyme of soil denitrifiers, soil pH, soil nitrate, organic matter, and water content. Reduction of N_2O to N_2 in denitrification is a strictly anaerobic process. The reducing environment can be found in soil aggregates, flooded or deeper layers of soil. The microorganisms responsible for N_2O reduction have been found to be

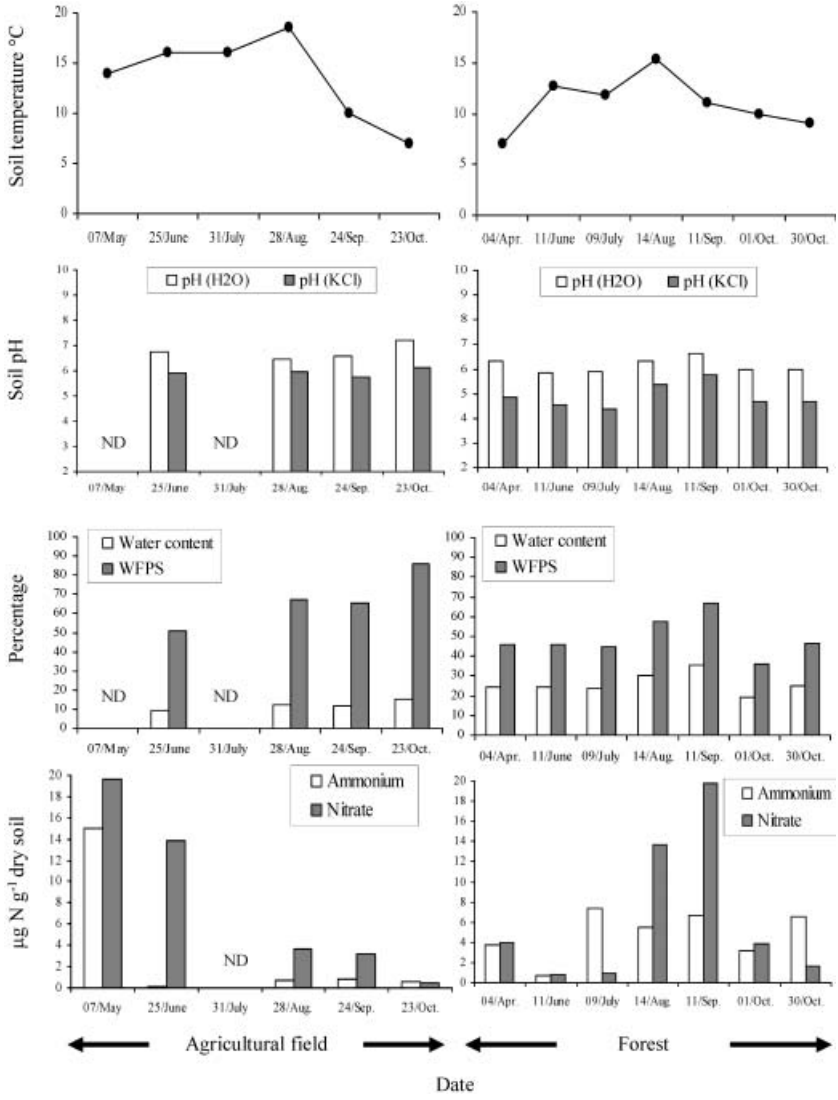

Figure 3. Major soil parameters during the field measurements. Sample soils for the laboratory incubation experiment were taken on 14 August for the forest soil and on 28 August for the agricultural soil, respectively. ND: not determined.

widely present in different ecosystems (Kromka, Stepamov, and Umarov 1992; Okereke 1993). The capacity of soil to reduce N_2O greatly depends on soil nitrate concentration, because nitrate has been found to inhibit N_2O reduction activity in a mechanism of electron competition (Blackmer and Bremner 1978; Letey et al. 1980; Terry and Tate 1980).

Lower pH has been found to inhibit N_2O reduction activity, resulting in higher N_2O/N_2 ratio in denitrification products (Firestone, Firestone, and Tiedje 1980), which might be partially responsible for the lower N_2O reduction activity in the forest soil than in the agricultural soil (Table 1). Nevertheless, N_2O reduction activity plays an important and a practical role in abating soil N_2O emissions, because N_2O concentrations in soil profiles have been commonly found much higher than the atmospheric levels and can be up to hundreds and even thousands ppmv (Yu, Chen, and Patrick 2004; Yu, Faulkner, and Patrick 2006).

CONCLUSIONS

Both the laboratory and field studies clearly indicate that the agricultural soil had a higher potential for N_2O reduction than the forest soil (Figures 1 and 2). Nitrous oxide reduction activity in denitrification has profound implications in an environment when N loss from an ecosystem is not preventable. The activity of N_2O reduction determines the N_2O/N_2 ratio in denitrification products before emission to the atmosphere. In some circumstances, soils may function as a sink of ambient N_2O when N_2O reduction activity out-competes N_2O production activity in soils. The two study sites did not function as a sink of the atmospheric N_2O, but N_2O reduction activity in the soils played an important role in abating the quantity of N_2O emissions from the fields. This is probably more critical for the fertilized agricultural field. Reduction of N_2O in soil is probably only a minor sink but may still play an important role on a global scale. The elimination of N_2O in the stratosphere is so slow that even a small sink may contribute significantly to reducing the atmospheric residence time of N_2O.

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