

Diurnal variation of N₂O and CH₄ fluxes from grazing semi-arid grassland ecosystem

Rui Du, Gengchen Wang and Daren Lu
Institute of Atmospheric Physics, CAS, Beijing 100029 China

Abstract

Experimental study on N₂O and CH₄ flux in Inner-Mongolia grassland was conducted by closed chamber method in 1998, respectively. Grazing *Aneurolepidium chinense* were chosen as temperate typical semi-arid steppe for experimental plot. Some preliminary results show that the Inner Mongolia grazing semi-arid grassland soil-plant system act as a source of N₂O and a sink of CH₄. The grazing grassland soils not only emit N₂O but absorb them in sometimes. The characters of diurnal variation were observed and discovered also in this paper. The annual fluxes of N₂O were reduced 40%~60% result from grazing, oppositely, it is not clearly for CH₄ annual fluxes.

Key words: Grazing, temperate typical semi-arid steppe, N₂O and CH₄ flux, diurnal variation

1 INTRODUCTION

Nitrous oxide (N₂O) and methane (CH₄) are two important greenhouse gases playing an important role in the photochemical reactions in the troposphere and in the global warming. Atmospheric Concentrations of these trace gases have being higher than their Concentrations in 1750 and increased at a rate of 151%(CH₄) and 17%(N₂O) (IPCC, 2001). These trace gases are thought to be the most important radioactively active trace gases in the atmosphere next to carbon dioxide (CO₂). Both N₂O and CH₄ are emission from different terrestrial ecosystems (agroecosystem, natural wetland, landfill, forest, grassland). As a main composition of the terrestrial ecosystem, grassland ecosystem takes an important role in global biogeochemical cycles and in the global environmental and climatic change research as well. N₂O and CH₄ emission from temperate semi-arid typical grassland ecosystem had been measured since 1995 in Inner Mongolia of China. In this paper, some different characteristics of N₂O and CH₄ fluxes emission from native and grazing temperate semi-arid typical grassland ecosystems are summarized.

2 MATERIALS AND METHODS

2.1 Field experiments

N₂O and CH₄ in-situ fluxes measurements were carried out in the native and grazing temperate semi-arid typical grassland sample plots of Inner Mongolia Grassland Ecosystem Research Station (IMGERS) (43°38'N,116°42'E) which located within the Baiyinxile Livestock Farm of the Xilingol League of Inner Mongolia Autonomous Region with an altitude of 1187m. The climate of the area is temperate zone, semi-arid and continental grassland climate type. *Aneurolepidium chinense* steppe and *Stipa grandis* steppe are the most important grassland vegetation community in this region. The *A.c* native fenced permanent site (500×500m² in size) were set up in 1979. The characteristics of the plot are shown in table 1. There was no any human management (watering, fertilizing, mowing and farming) in the native sampling plot. In the other hand, the grazing sampling plot was chosen nearby the native fenced permanent site. The closed chamber technique (Du. et al.,2000) was used for flux measurements. Three replicates of closed chamber were laid out in equilateral triangle design in the plots.

Table 1: The main background characteristics of sample plot

soil type	soil nutrition (0 ~ 10cm)				soil moisture	communitical representative	ground biomass
	organ	total N	total P	PH			
dark chestnut soil	3.36	0.206	0.080	6.6	7 ~ 20%	<i>Aneurolepidium chinense</i>	142

2.2 Collect and analysis of greenhouse gases

Diurnal fluxes measurements were made once in each different month during the whole growing period of the grazing steppe. They were before heading period(June), following period(July), seeding period(August) and nutriunt after seeding period(September), respectively. Gases sampling were carried in every three hours.

We measured nitrous oxide and methane fluxes by using three chambers for each time gas samples are taken from chambers with 50-ml polypropylene syringes at time of 0, 20,40 and 60 minutes after the chambers is covered. We analyzed the samples within 10 hours by HP 5890 gas chromatography using a 60/80 mesh and 80/100 mesh Porapak Q column and flame ionization detector for CO₂ and CH₄, the oven, injector, detector and converter temperatures are 45 , 90 , 150 and 380 ,respectively, and carrier gas

flow rate was $30\text{ml N}_2 \text{ min}^{-1}$. Porapak Q and electron capture detector are used for N_2O from the same syringe, the oven, injector and detector temperatures were 45°C , 160°C and 380°C , respectively.

3 RESULT AND DISCUSSION

3.1 Variation of N_2O flux

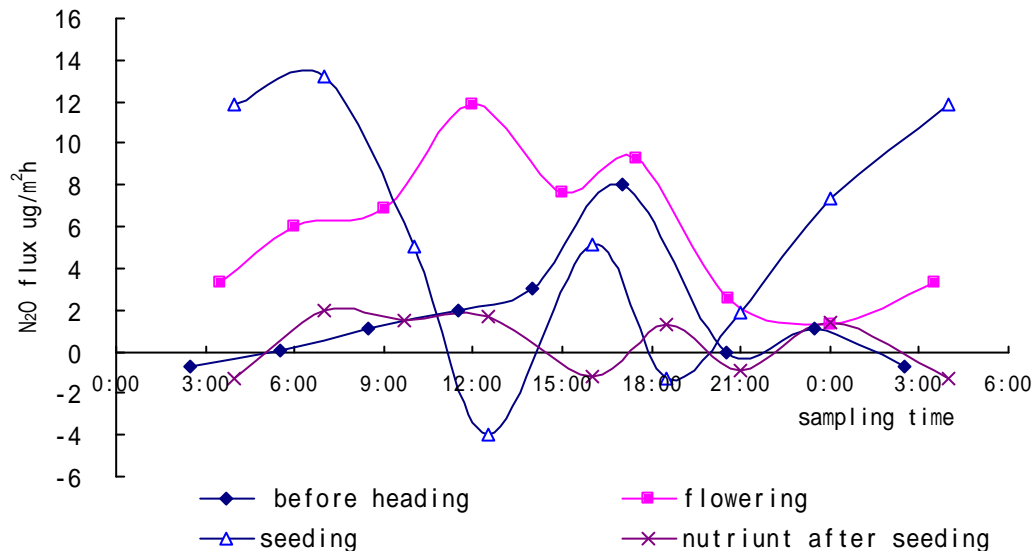


Fig1 Diurnal variation of N_2O flux from grazing A.c steppe

Fig 1 shows a typical behavior of N_2O flux variation. There is an obviously variation in N_2O daily flux. It is reported that a general feature of the emission of N_2O from the sward has been a clearly-defined diurnal cycle with maximum rates occurring in the afternoon and minimum rates near sunrise (Denmenad et al.,1979). The diurnal variation of N_2O emission from grazing steppe appears to be differently with that variation from the native A.c steppe (Du Rui et al 1998). There were some absorb N_2O fluxes due to the grazing, however, the grazing steppe is still a source of N_2O . There is a hysteresis effect between the peak value and the time company with change of season. The dialy emission amount appears to be closely associated with variation in the plant growth season of the semi-arid grassland (table 2). It shows that the peak of N_2O emission is often in the high season of the grassland plants. Compared with native steppe(fencing plot),the N_2O flux is lower due to grazing(table 4). In the meantime, the emission mode of N_2O flux from grazing A.c. steppe is also changed, it is not a clearly feature because its peak's time is different in

different day.

Table 2 The diurnal variation of N₂O flux from grazing A.c. steppe

	flux range ugN ₂ O m ⁻² h ⁻¹	diurnal average ugN ₂ O m ⁻² h ⁻¹	diurnal range ugN ₂ O m ⁻² h ⁻¹	total emission ugN ₂ O m ⁻² d ⁻¹
Before heading	-0.75 ~8.03	1.93	8.78	43.4
Flowering	1.30~11.85	5.97	10.55	143.2
Seeding	-4.0~13.26	4.94	17.26	118.6
Nutriunt after seeding	-1.30~1.93	0.50	3.23	11.9

3.2 Variation of CH₄ flux

Fig 2 shows diurnal variation of CH₄ flux from grazing A.c. steppe, the effect of grazing on CH₄ flux is not strong as same as that of native A.c. steppe (Du Rui et al 1998). There is not distinct diurnal variation mode of CH₄ flux from both native and grazing steppe. The diurnal variation of CH₄ flux is reduced and the diurnal range is lower result from grazing, because there are not other factors besides the grazing between these two plots. However, the grazing is not affect that semi-arid steppe soil was the sink of the CH₄.

Table 3 The diurnal variation of CH₄ flux from grazing A.c. steppe

	flux range ugCH ₄ m ⁻² h ⁻¹	diurnal average ugCH ₄ m ⁻² h ⁻¹	diurnal range ugCH ₄ m ⁻² h ⁻¹	total emission mgCH ₄ m ⁻² d ⁻¹
Before heading	-78~-46	-66.0	35	-1.58
Flowering	-131~-60	-78.5	71	-1.88
Seeding	-30~-5	-20.5	25	-0.49
Nutriunt after seeding	-51~-68	-60.5	17	-1.45

Table 4 Annual flux of N₂O& CH₄ from native and grazing steppe(Lu Daren et al. 2002)

Annual flux Kg/ha.a	Native A.c steppe	Grazing A.c steppe
N ₂ O	0.38	0.24
CH ₄	-3.50	-3.61

4. Results

4.1 The diurnal variation of N₂O flux from grazing steppe appears distinctly but there is not clearly mode in different day. This is the obvious difference between with the N₂O fluxes from native and grazing steppes.

4.2 The diurnal variation of CH₄ flux from grazing steppe appears not clearly same as that of N₂O flux.

4.3 Because of the grazing, N₂O flux is reduced from grazing steppe.

However, the effect on CH₄ flux is not clearly, it reduced the degree of CH₄ flux daily changing.

4.4 Although there are some absorption N₂O fluxes from grazing steppe, it is not effect that the semi-arid grassland is the source of the N₂O.

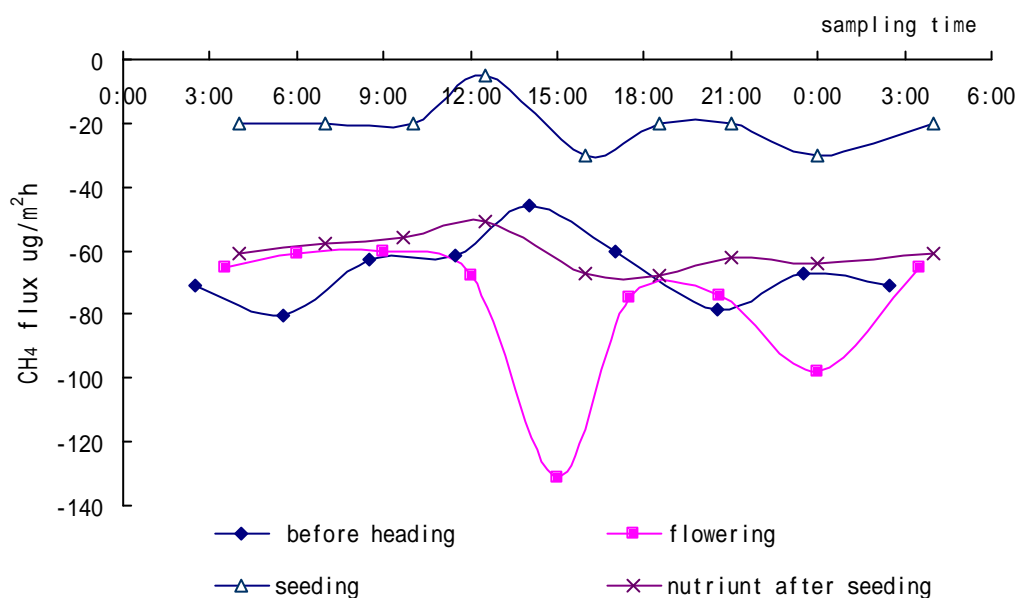


Fig2 Diurnal variation of CH₄ flux from grazing A.c steppe

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