NANJING UNIVERSITY

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Measuring N_2O fluxes from urban grass in Xianlin Campus

Introduction

N_2O:

- Greenhouse gas with global warming potential 310 --> over 100 years
  - in comparison CO_2 and CH_4 --> 1 and 21 [1]
- Ozone depleting substance
  - not regulated by Montreal Protocol
  - cause depleting through NO and NO_2 formation
    - react with oxygen radicals needed for ozone formation [2]
- current (2023) concentrations: 337 ppbv

N_2O emissions:

- concentrations growing at 0.2-0.3% per year due to anthropogenic activities [3]
- formed by both nitrification and denitrification
- emphasized by fertilization
- high temperature and humidity increase production [6]

Nanjing, China:

- in July in average: 34°C and 220 mm

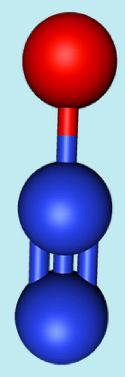

Fig. 1: N_2O molecule

Research objectives

How are the N_2O fluxes affected throughout the day and what is the impact of high maintenance urban grass on the campus' total emissions?

- Obtain nitrous oxide emissions and fluxes throughout the day in three different locations
- Quantify the magnitude of N_2O emissions in campus

Method

Instruments:

- LI-7820 N_2O/H_2O Trace Gas Analyzer
  - Optical Feedback – Cavity Enhanced Absorption Spectroscopy
  - measures dry mole fraction
- 8100-104 Opaque Long-Term Chamber
  - motorized chamber, autonomous measurements
- LI-8100A Analyzer Control Unit
  - for soil temperature and humidity
- LI-8150 Multiplexer
  - Manage all connections

Measurements:

- Short term measurements:
  - 2 min observation and 2 min interval
  - 6 cycles per spot
- Long term measurements:
  - 2 min observation and 15 min interval
  - 20 to 40 cycles per location
- Additional soil temperature and humidity measurements

3 locations in Xianlin Campus, Nanjing, China:

- Forest --> 30% of the campus
- Unused land --> 10% of the campus
- Garden --> 15% of the campus

Processing:

- Convert concentrations to fluxes

$$V \cdot \frac{dC}{dt} = A \cdot F_S$$

- Closed path system
  - Fout-Fin =0

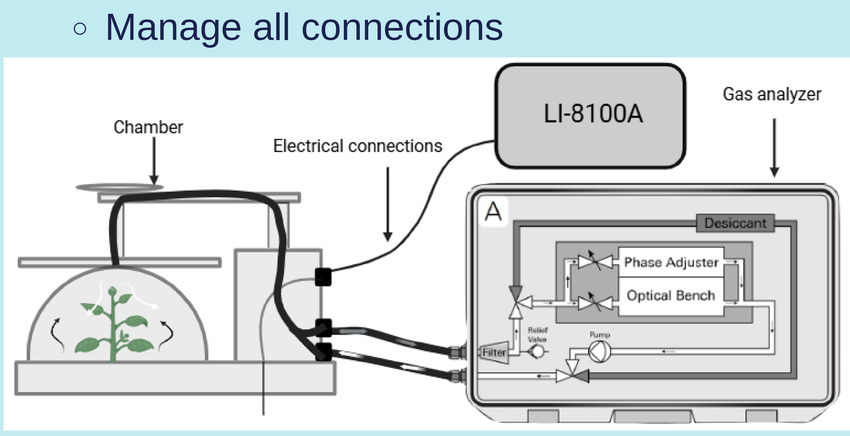

Fig. 2: Diagram of the instrumental setup with gas flow path

Fig. 3: Picture of the experimental setup

Fig. 4: Soil types at each location; from top to bottom garden, unused land and forest.

Fig. 5: Map of Xianlin Campus at Nanjing University with the different areas of measurements

Results & discussion

Fig. 6 and 7:

- Despite having more controlled environment, garden area is not the highest in flux
- Can be caused by the variation in time
  - forest measurements done in morning
  - unused land measurements done in afternoon
  - garden measurements done in evening
- Y. Zhan et al. --> similar results [5]
  - lawn has higher emission rates than urban forest

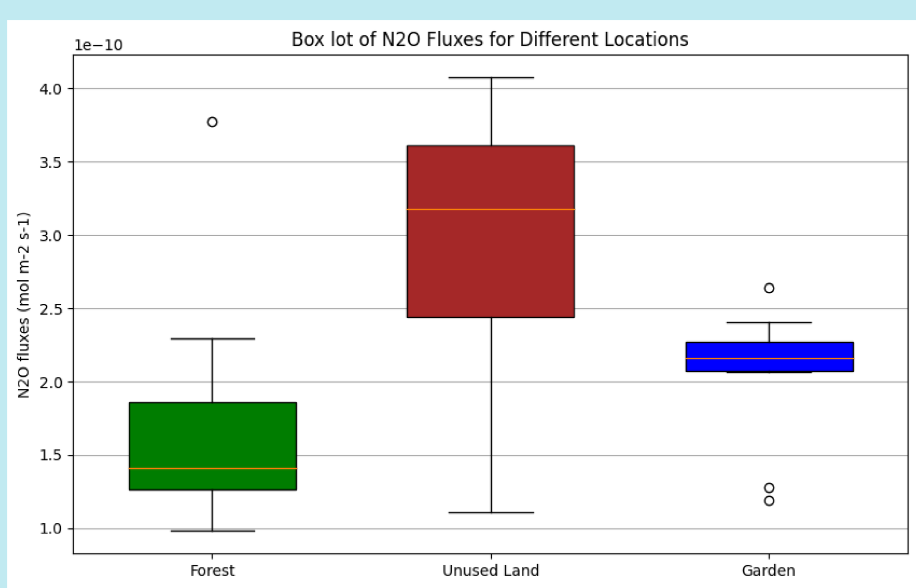

Fig. 6: Box plot of all fluxes for each location, short measurement time.

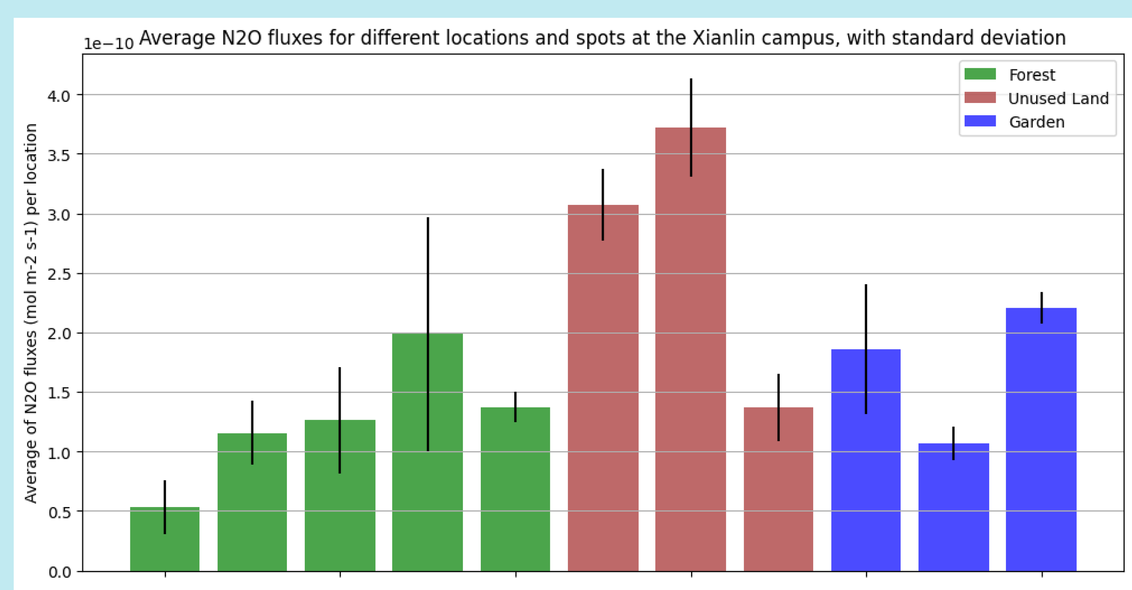

Fig. 7: Average of all fluxes per spot for each location, short measurement time.

Fig. 8:

- All measurements peaked around noon
- Anormal results for both forest and unused land
  - Y. Zhan et al. --> N_2O fluxes ranging from 0.3 to 1 mol m^2 s^{-1} [4]

Fig. 9:

- No correlation found, all R^2 values too low
- Very little change in temperature and water content
  - especially for the garden area, only measurements in shadow
  - forest and unused land measurements in both shadow and light
- Opposed to X. Xu et al. --> whom indicated strong correlation [6]

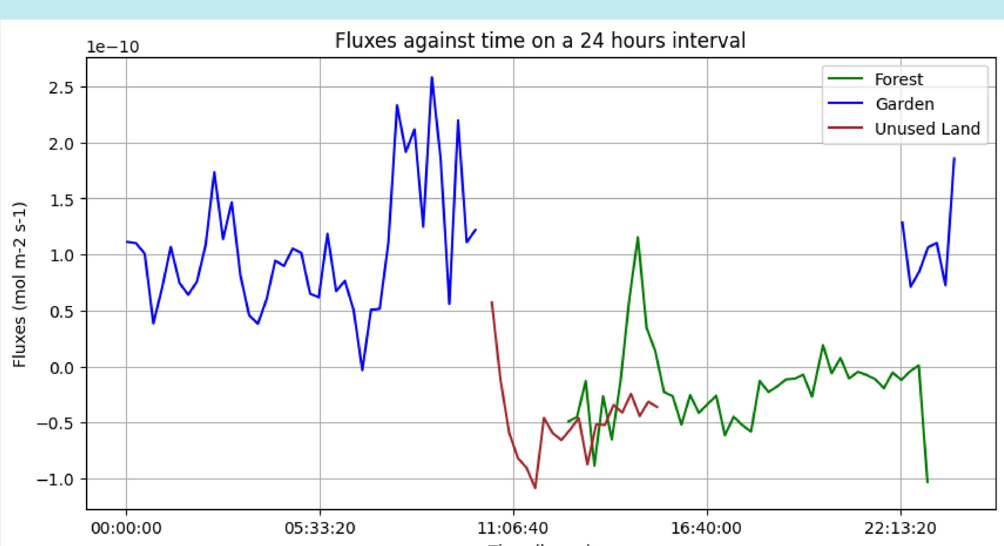

Fig. 8: N_2O flux variation over 24 hour for each location, long measurement time.

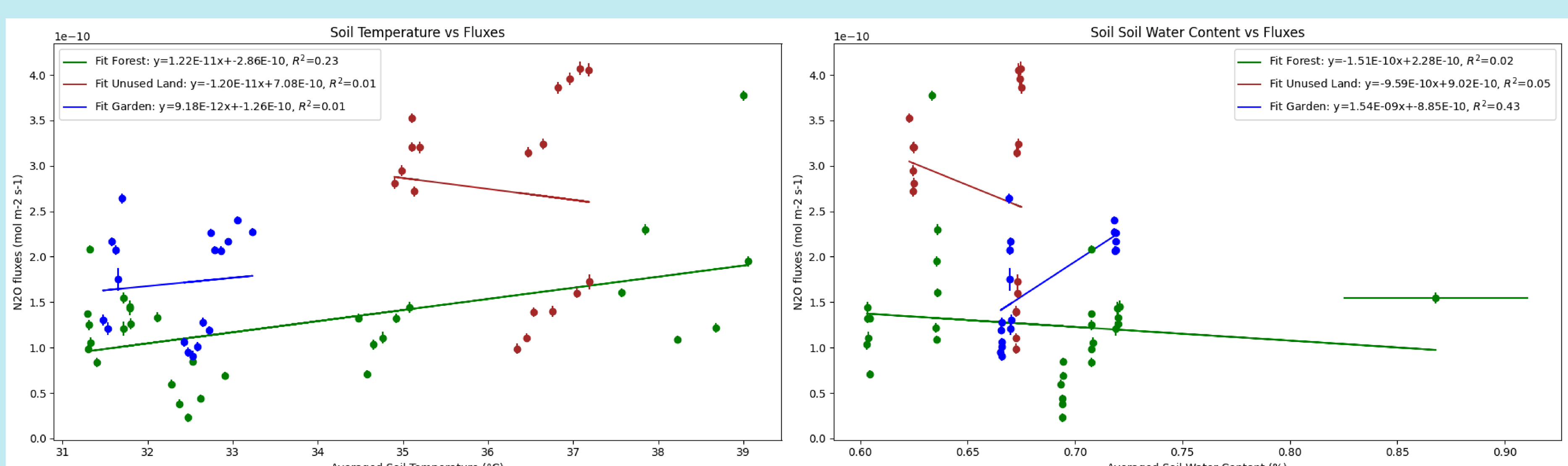

Fig. 9: Correlation between N_2O fluxes and soil temperature and soil water content for each location, short measurement time.

Conclusions

- Unused land and garden have the highest emissions
- N_2O fluxes are higher in the middle of the day
- As opposed to sources, no correlation between soil temperature, soil water content and fluxes were found

Future studies:

- Look at the 24 hrs cycle of N_2O flux in all three environments
- Observe temperature and water content correlations with N_2O fluxes over a larger range of values

References

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[3] M. A. K. Khalil, R. A. Rasmussen, and M. J. Shearer, "Atmospheric nitrous oxide: patterns of global change during recent decades and centuries," Chemosphere, vol. 47, no. 8, pp. 807–821, Jun. 2002, doi: https://doi.org/10.1016/s0045-6535(01)00297-1.
[4] Y. Zhan et al., "Characteristics of annual N2O and NO fluxes from Chinese urban turfgrasses," Environmental Pollution, vol. 290, p. 118017, 2021, doi: https://doi.org/10.1016/j.envpol.2021.118017.
[5] Y. Zhan et al., "Urbanization can accelerate climate change by increasing soil N2O emission while reducing CH4 uptake," Global Change Biology, vol. 29, no. 12, Mar. 2023, doi: https://doi.org/10.1111/gcb.16652.
[6] X. Xu et al., "Soil N2O emission in Cinnamomum camphora plantations along an urbanization gradient altered by changes in litter input and microbial community composition," Environmental pollution, vol. 299, pp. 118876–118876, Apr. 2022, doi: https://doi.org/10.1016/j.envpol.2022.118876.