Temporal variation of $N_2O$ flux from agricultural landscapes based on eddy covariance method
Background

- \( \text{N}_2\text{O} \) is one of the most important greenhouse gases and the dominant stratospheric ozone-depleting substance (Stocker et al, 2013; Ravishankara et al., 2009).

- Due to nitrogen fertilizer application, agricultural ecosystems are considered as the biggest anthropogenic source of \( \text{N}_2\text{O} \) emissions, which contribute nearly 80% of the global anthropogenic \( \text{N}_2\text{O} \) budget (Crutzen et al., 2008; Davidson et al., 2009).

(Aliyu et al., 2019)
Background

Drivers and processes of soil N$_2$O emissions across temporal and spatial scales

Measurement method
Drivers of N$_2$O flux

(Butterbach-Bahl et al., 2013)
The Yangtze River Delta is the major agricultural region in China. The agricultural structure is complex in this region.

Magnitude of \( \text{N}_2\text{O} \) flux??

Impact factors on \( \text{N}_2\text{O} \) flux??

(Zhou et al., 2014)
Objectives

- What is the magnitude and temporal variation of N₂O flux from agricultural landscapes?
- How do N₂O flux respond to environmental conditions?
The EC tower is located in Quanjiao, Anhui Province (31.9672°N, 118.2607°E).
Materials and methods: flux measurements

(a) 70 m
50 m Micrometeorology
10 m Micrometeorology & Radiation

(b) CP system: TGA 200A + CSAT3B

(c) OP system: EC150 + CSAT3

(d) Setup of the tubing system

Clean air

Vortex intake

Dirty air

TGA

75 m

Filter

Pump

Needle valve

Dryer

Reference gas

Vacuum line

Sample line
Materials and methods: data process

**EC150 system**
- Double rotation
- WPL corrections
- Spectral correction
- Quality flags
- Precipitation events flagged
- Threshold value control
- Abnormal data removed

**TGA system**
- Double rotation
- Time lags
- Spectral correction
- Quality flags
- Threshold value control
- Abnormal data removed

10Hz data

30-min data

EddyPro software (version: 6.2.1)
Materials and methods: ancillary data

✓ Footprint estimation: Flux Footprint Prediction method (Kljun et al., 2015)

✓ Daily precipitation: Chuzhou station (http://data.cma.cn/)

✓ NDVI data: proba-v products (https://proba-v-mep.esa.int/applications/time-series-viewer/app/app.html)
Results analysis

- The performance of the TGA system
- Temporal variations of N$_2$O flux from agricultural landscapes
- Environmental factors on N$_2$O flux
Time lag estimation:

Covariance maximization method:

\[ r(t) = \frac{w'(t + \tau)\rho_c'(t)}{\sigma_w \sigma_{\rho_c}} \]

Time lag: covariance maximization with default, but restrict the range of time lag: 6.4-8.4 s

Time lag: 7.4 s
Spectral analysis:

### Power spectra

**Normalized spectral $nS_x/\sigma_x^2$ vs. normalized frequency, $f = n(z-d)/U$**

- **Data Symbols:**
  - $u$
  - $v$
  - $w$
  - $T_s$
  - CO$_2$
  - N$_2$O

- **Line:** Kaimal model

### Cospectra

**Normalized cospectra $nC_{wX}/cov(wX)$ vs. normalized frequency, $f = n(z-d)/U$**

- **Data Symbols:**
  - $w'u'$
  - $w'v'$
  - $w'T_s'$
  - $w'CO_2'$
  - $w'N_2O'$

- **Line:** Kaimal model

**Time Period:** 2019_8_16 12:00-15:00
• On half-hourly scale, CO$_2$ flux measured by the TGA system agreed well with that from the EC150 system.
Footprint analysis

Main land use types: cropland and water body
$N_2O$ flux measurement: half-hourly scale
N$_2$O flux measurement: diurnal component

<table>
<thead>
<tr>
<th></th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daytime</td>
<td>0.93 ± 3.59</td>
<td>1.48 ± 3.91</td>
<td>1.63 ± 4.18</td>
<td>0.74 ± 3.42</td>
<td>1.16 ± 3.78$^a$</td>
</tr>
<tr>
<td>Nighttime</td>
<td>0.43 ± 1.85</td>
<td>0.84 ± 1.93</td>
<td>0.47 ± 1.31</td>
<td>0.17 ± 1.28</td>
<td>0.43 ± 1.58$^b$</td>
</tr>
</tbody>
</table>

Note: different letters denote significant differences.
N$_2$O flux measurement: daily scale

![Flux Measurement Graph](image-url)
$N_2O$ flux measurement: monthly scale

<table>
<thead>
<tr>
<th></th>
<th>Growing season</th>
<th>Non-growing season</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_n$ (nmol m$^{-2}$ s$^{-1}$)</td>
<td>1.15 ± 3.13</td>
<td>0.55 ± 2.65</td>
</tr>
</tbody>
</table>
Environmental factors on N$_2$O flux: air temperature

- **Growing season**
  - $y = 0.02x + 0.68$
  - $R^2 = 0.02$
  - $n = 177$, $p = 0.09$

- **Non-growing season**
  - $y = 0.023x + 0.26$
  - $R^2 = 0.10$
  - $n = 279$, $p < 0.01$
Environmental factors on $\text{N}_2\text{O}$ flux: precipitation
Comparison with other literatures

![Graph showing comparison with other literatures]
Conclusions

- During the measurement period (Oct. 2018 – Jul. 2020), N\textsubscript{2}O flux ranged from -1.07 to 3.92 nmol m\textsuperscript{-2} s\textsuperscript{-1}, with mean value of 0.77 ± 0.68 nmol m\textsuperscript{-2} s\textsuperscript{-1} on daily scale.

- N\textsubscript{2}O flux in growing season (1.15 ± 3.13 nmol m\textsuperscript{-2} s\textsuperscript{-1}) was higher than that in non-growing season (0.55 ± 2.65 nmol m\textsuperscript{-2} s\textsuperscript{-1}), and it accounted for 67% of the total flux.

- There was no relation between N\textsubscript{2}O flux and \( T_a \) in growing season, but a weak positive relation in non-growing season. And precipitation had greater influence on N\textsubscript{2}O flux from growing season.
Next work

• To estimate the contribution of $N_2O$ flux from different underlying types.

• To measure $N_2O$ flux from a single rice paddy field by static chamber method.
Thank you for your attention!