Yale-NUIST Center on Atmospheric Environment

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

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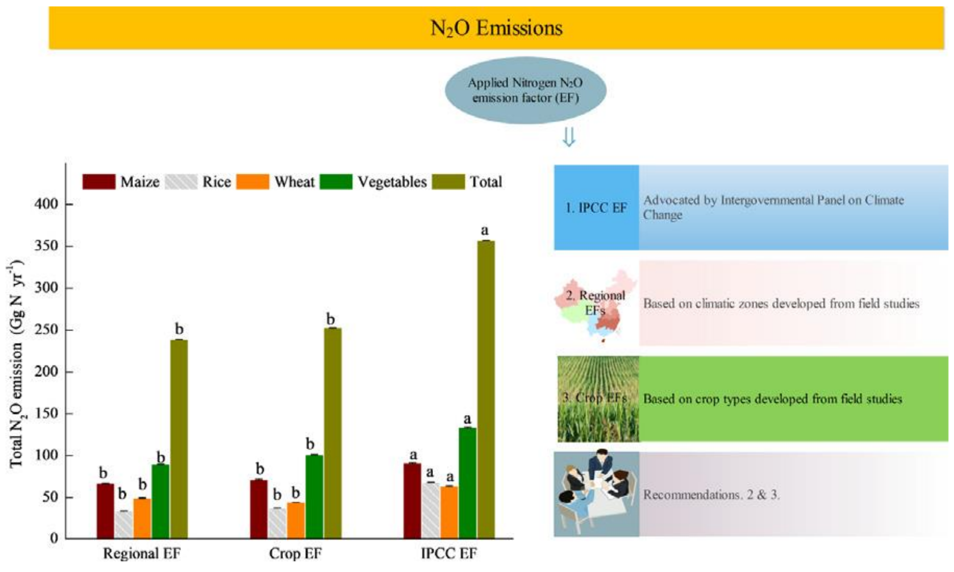
Background

- N_2O 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 fetilizer application, agricultural ecosystems are considered as the biggest anthropogenic source of N_2O emissions, which contribute nearly 80% of the global anthropogenic N_2O budget *(Crutzen et al., 2008; Davidson et al., 2009).*



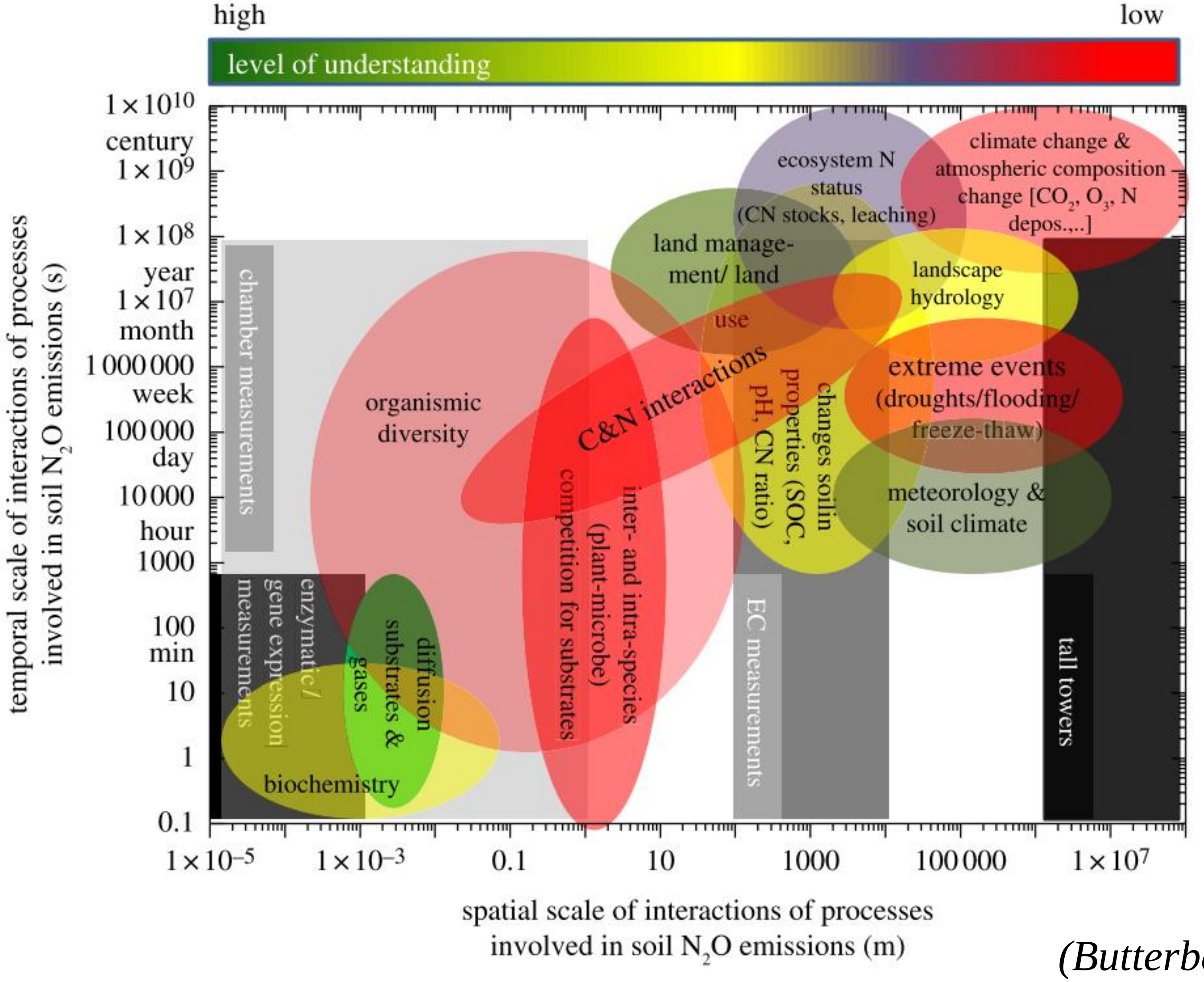
(Aliyu et al., 2019)

Single agricultural ecosystem ⇨ Complex agricultural ecosystems

Field scale ⇨ Landscape scale ?

Background

Drivers and processes of soil N_2O emissions across temporal and spatial scales



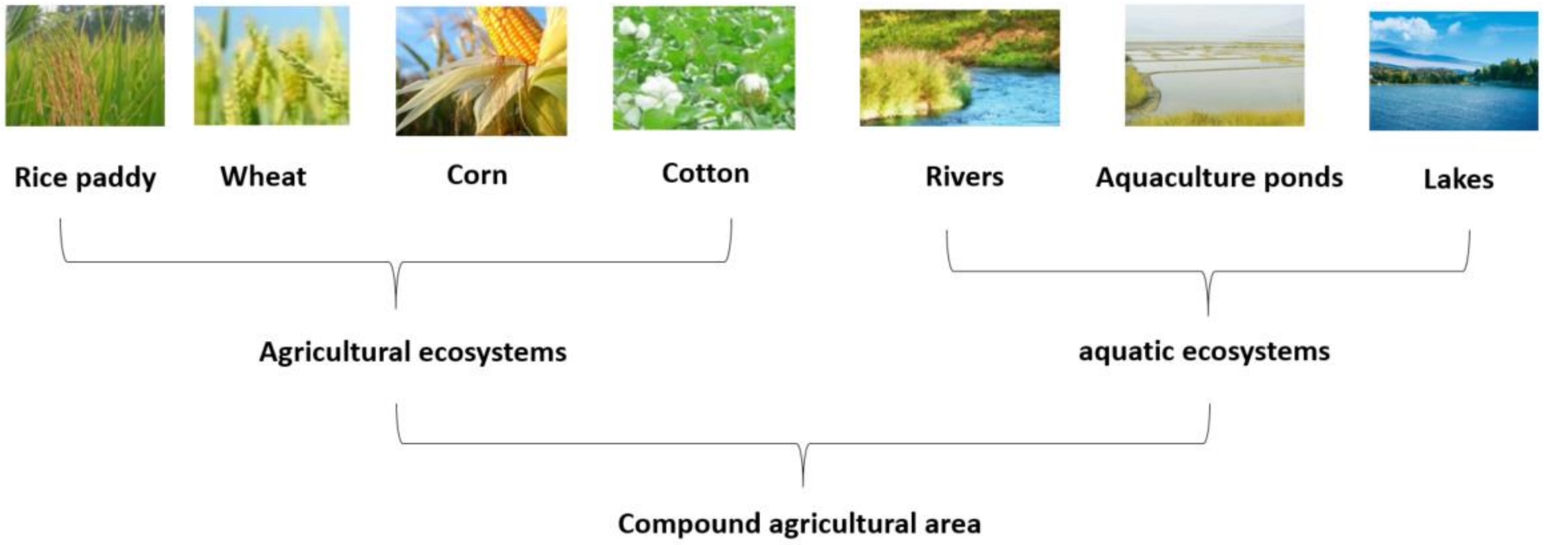
Mesurement method

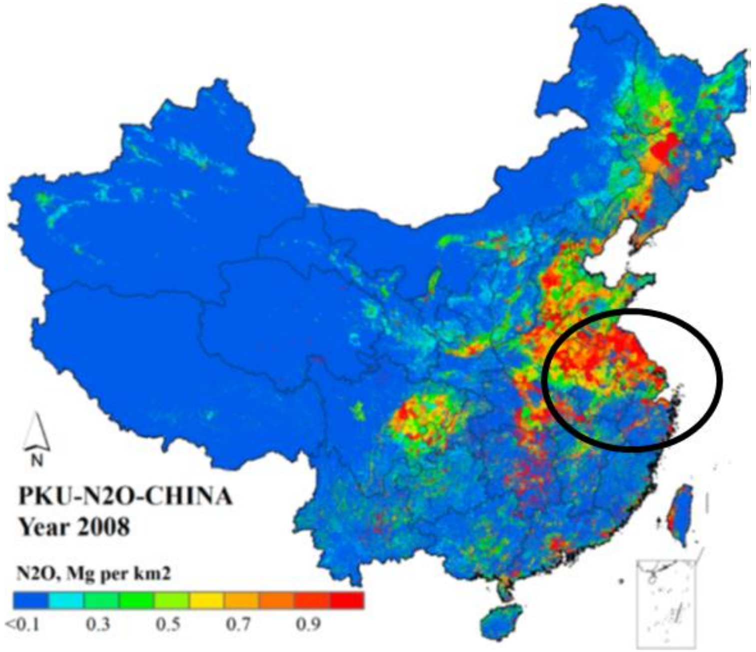
Drivers of N_2O flux

(Butterbach-Bahl et al., 2013)

Background

- The Yangtze River Delta is the major agricultural region in China. The agricultural structure is complex in this region.





(Zhou et al., 2014)

Magnitude of N_2O flux??

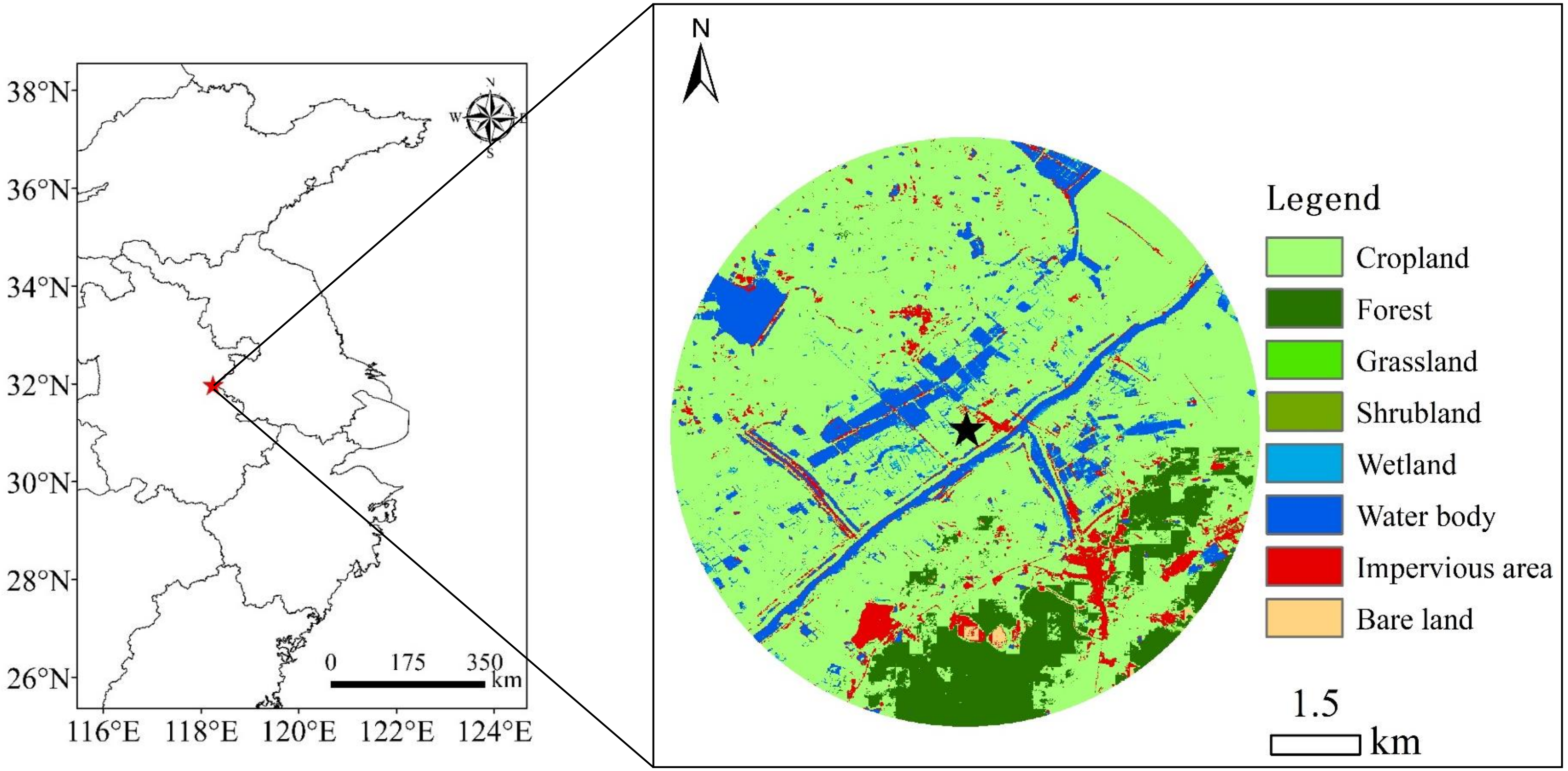
Impact factors on N_2O flux??

Objectives

- What is the magnitude and temporal variation of N_2O flux from agricultural landscapes?
- How do N_2O flux respond to environmental conditions?

Materials and methods: site description

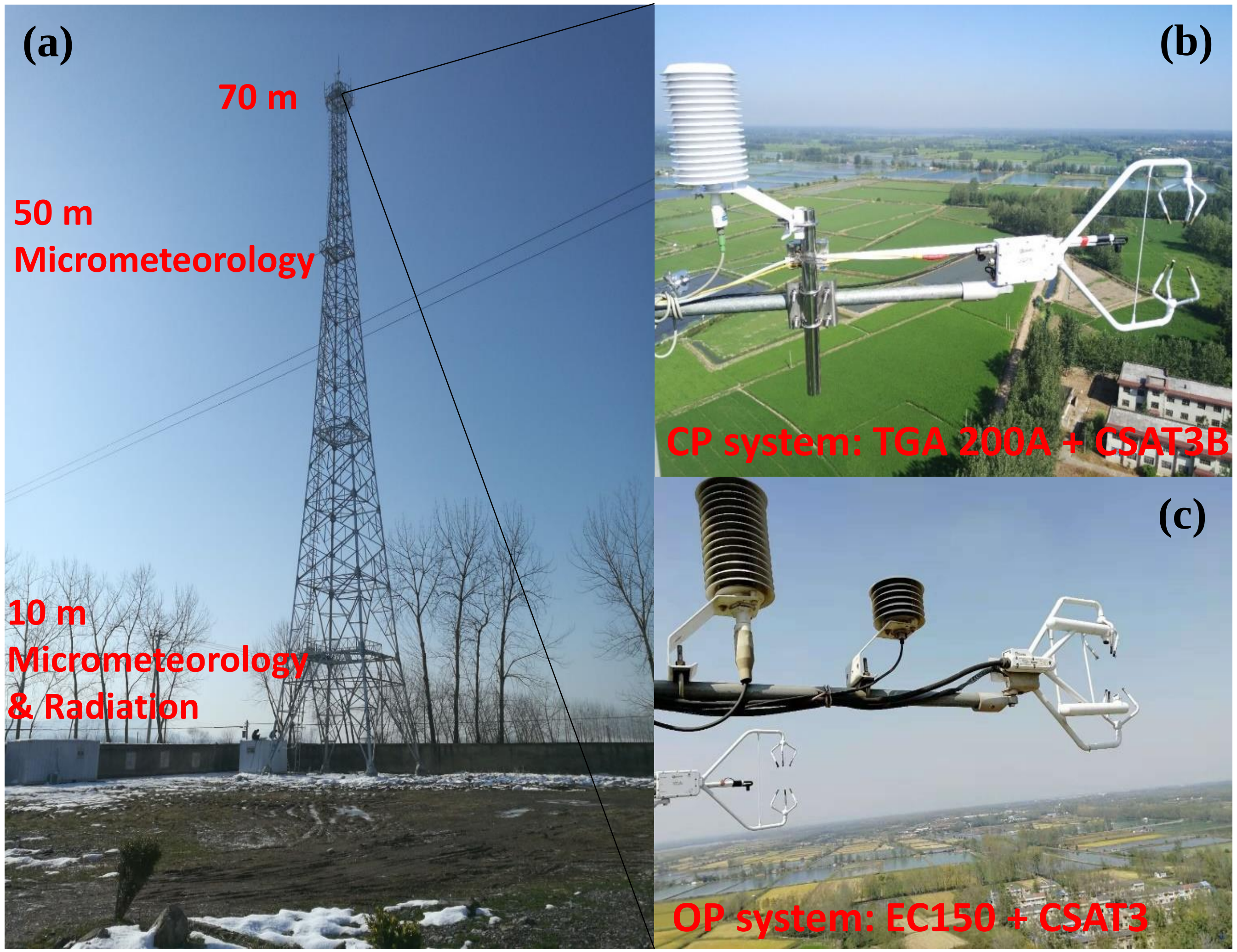
- ✓ The EC tower is located in Quanjiao, Anhui Province (31.9672°N, 118.2607°E).



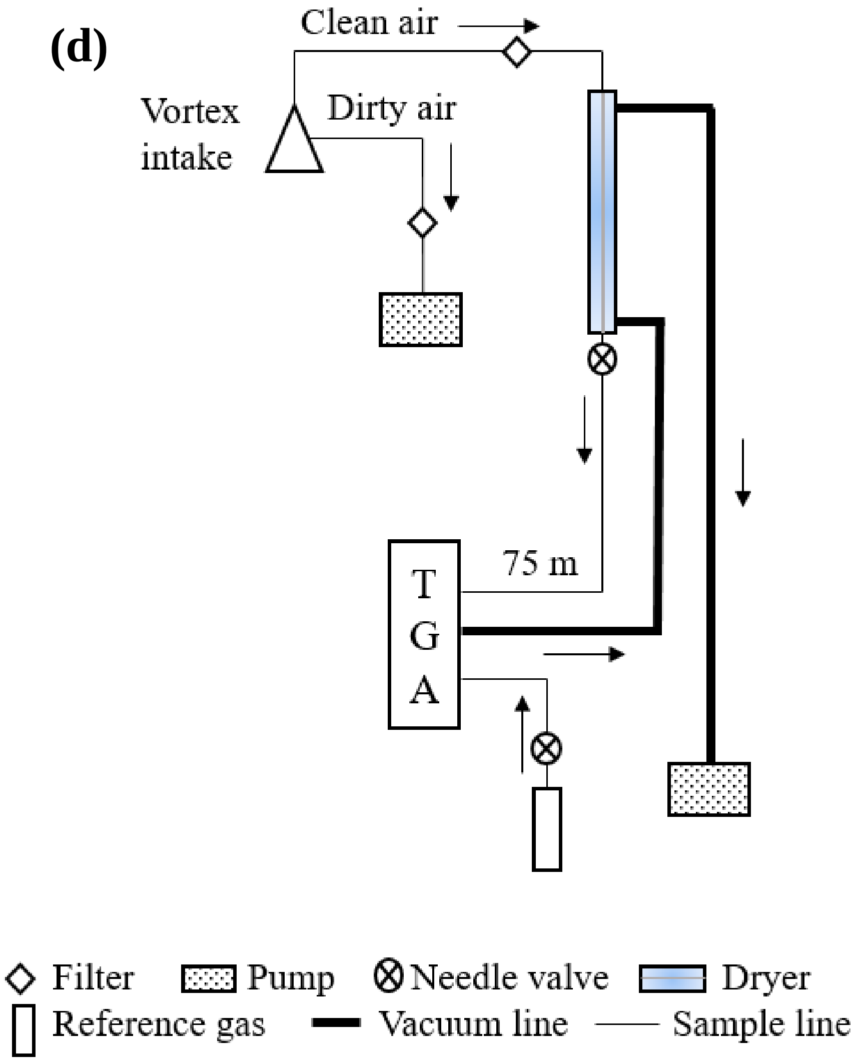
Land cover surrounding the tower in a 5 km radius.

Land use types	Ratio
Cropland	73.1%
Forest	10.1%
Water body	9.8%
Impervious area	5.4%
Wetland	1.0%
Grassland	0.3%
Bare land	0.2%
Shrubland	0.03%

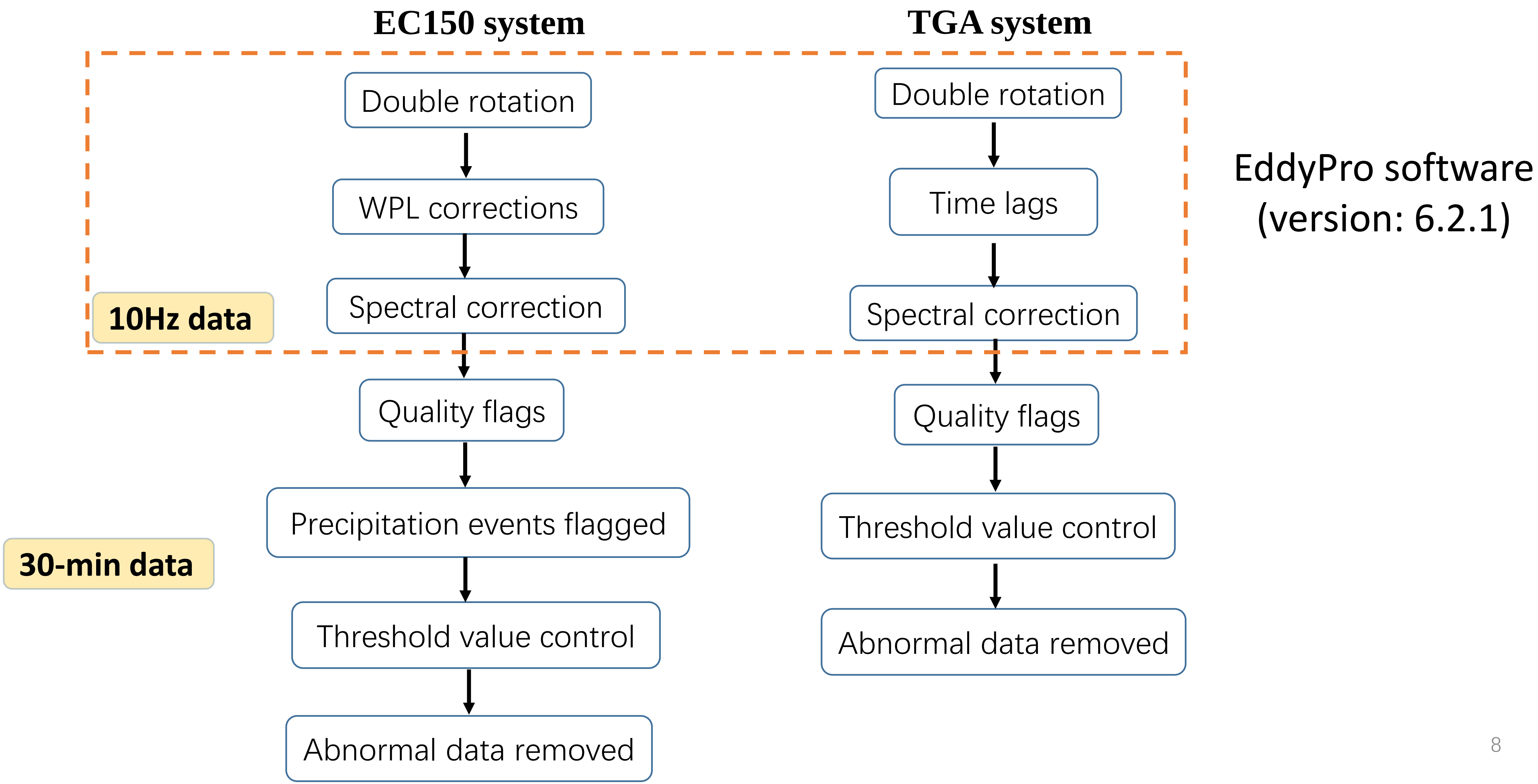
Materials and methods: flux measurements



Setup of the tubing system



Materials and methods: data process



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_2O flux from agricultural landscapes
- Environmental factors on N_2O flux

Time lag estimation:

Covariance maximization method:

$$r(\mathrm{t}) = \frac{\overline{w'(t+\tau)\rho_c{}'(t)}}{\sigma_w \sigma_{\rho_c}}$$

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

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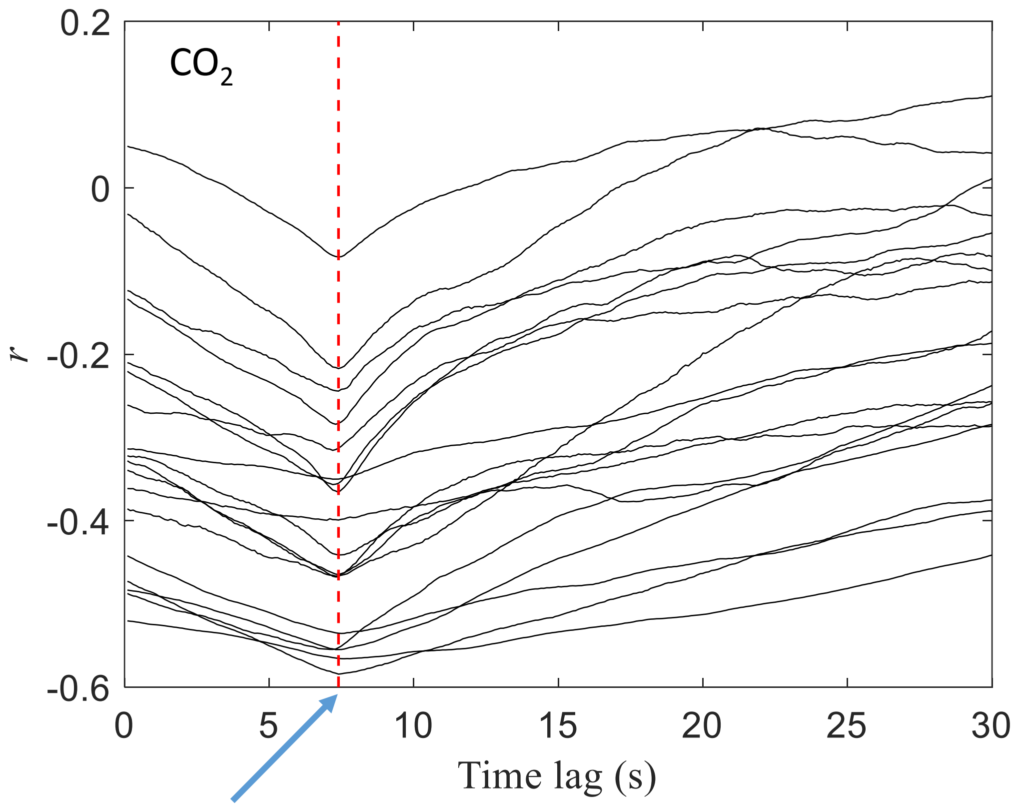

Time lag: 7.4 s

Spectral analysis:

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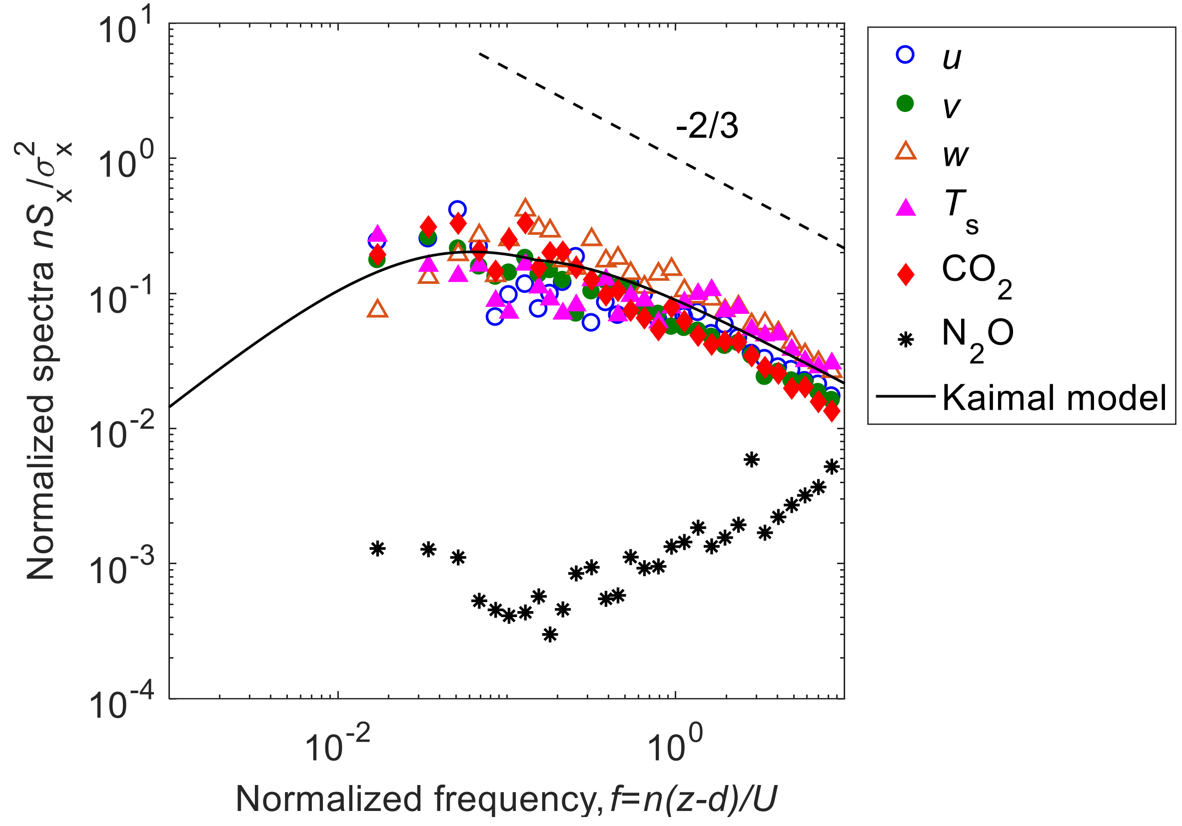
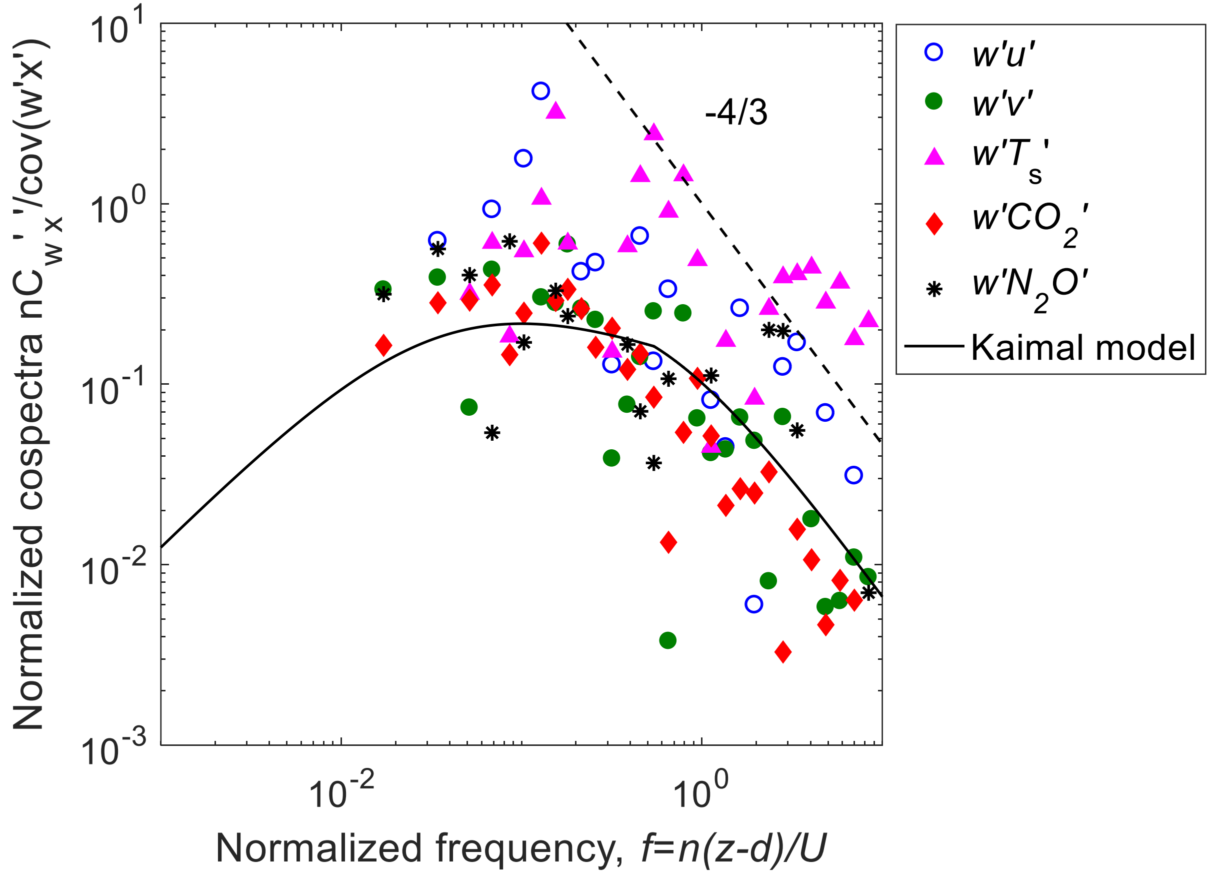
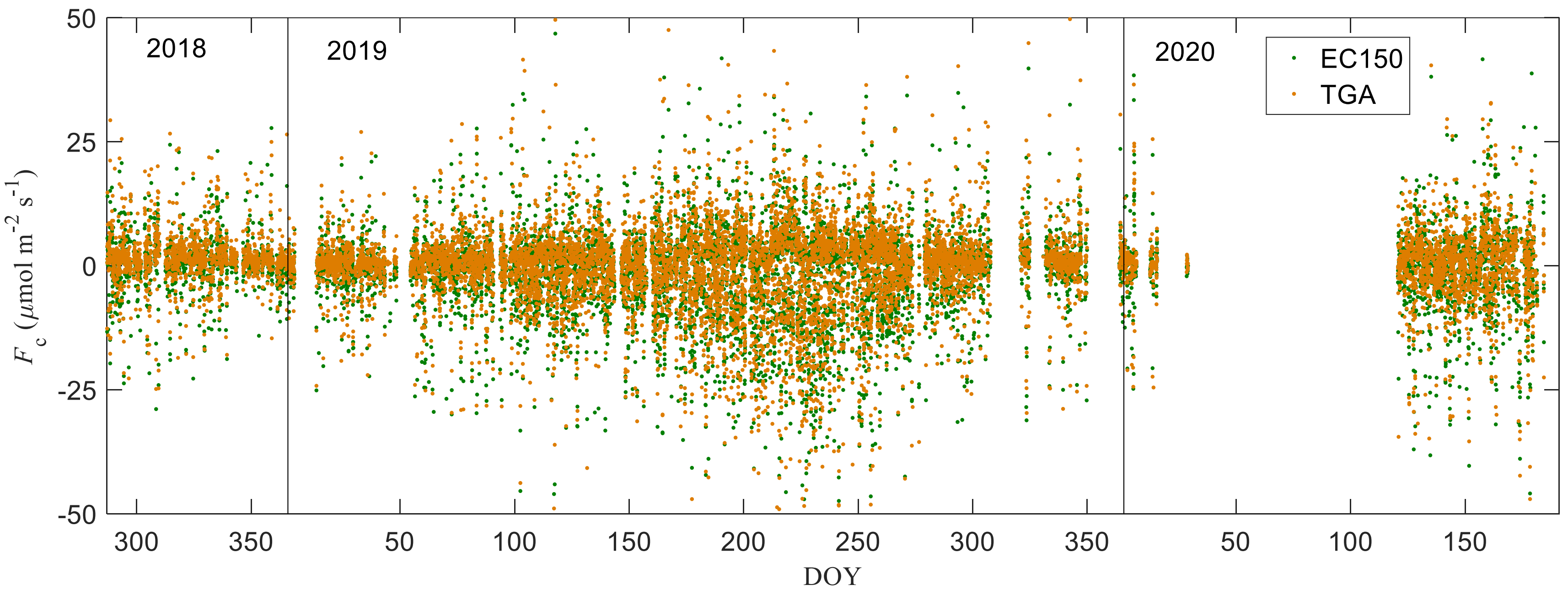
Power spectra

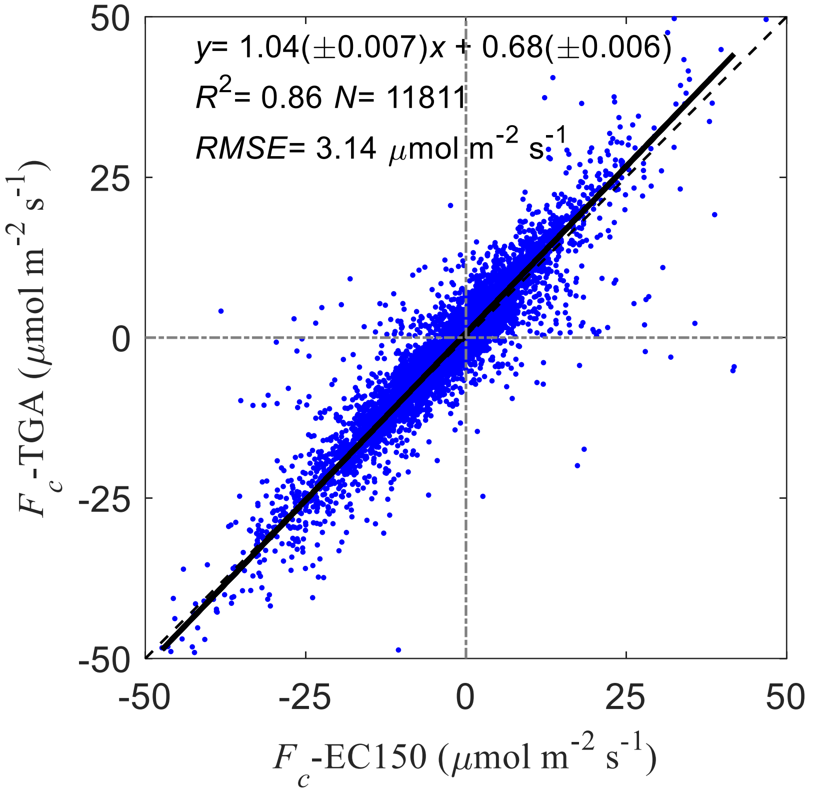


Cospectra



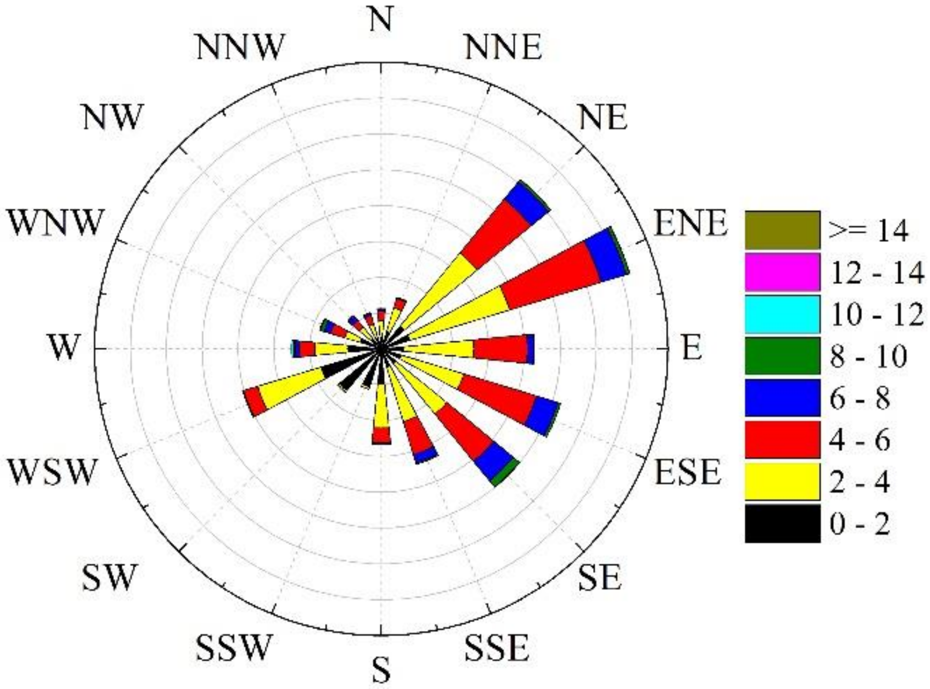
Comparison of CO_2 flux : TGA system vs. EC150 system

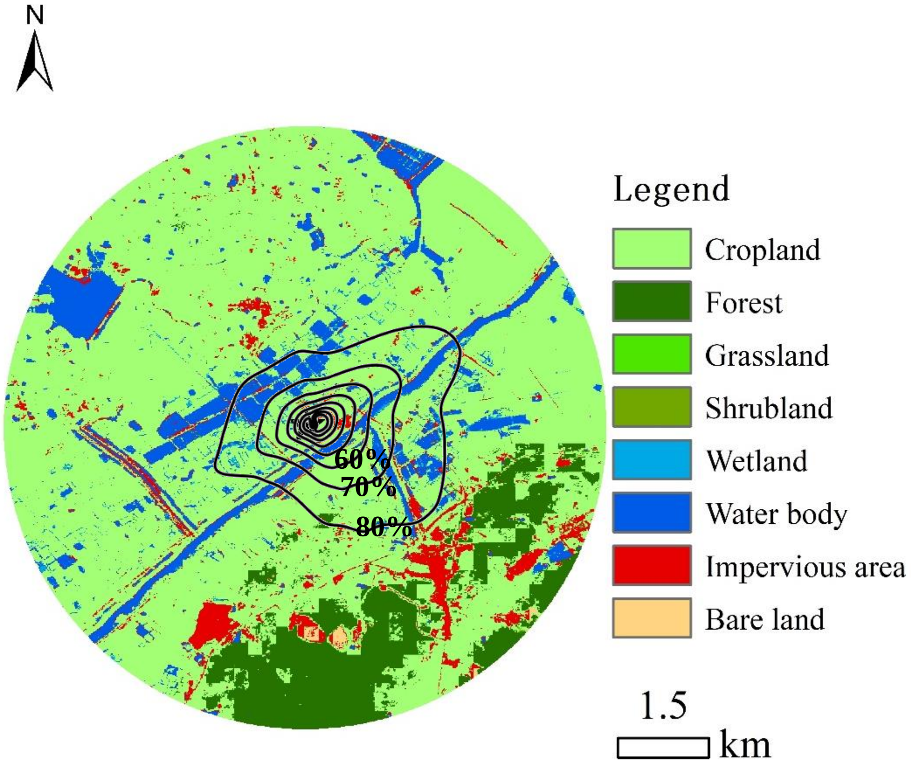




- On half-hourly scale, CO_2 flux measured by the TGA system agreed well with that from the EC150 system.

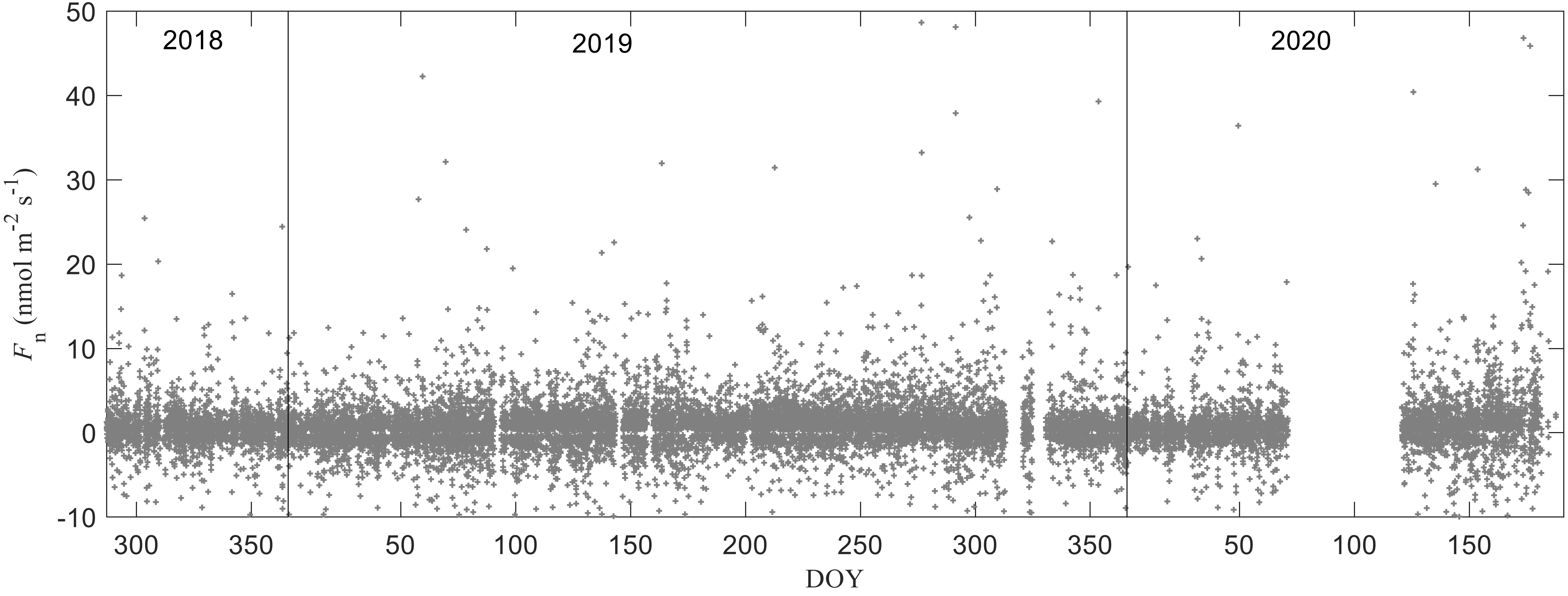
Footprint analysis



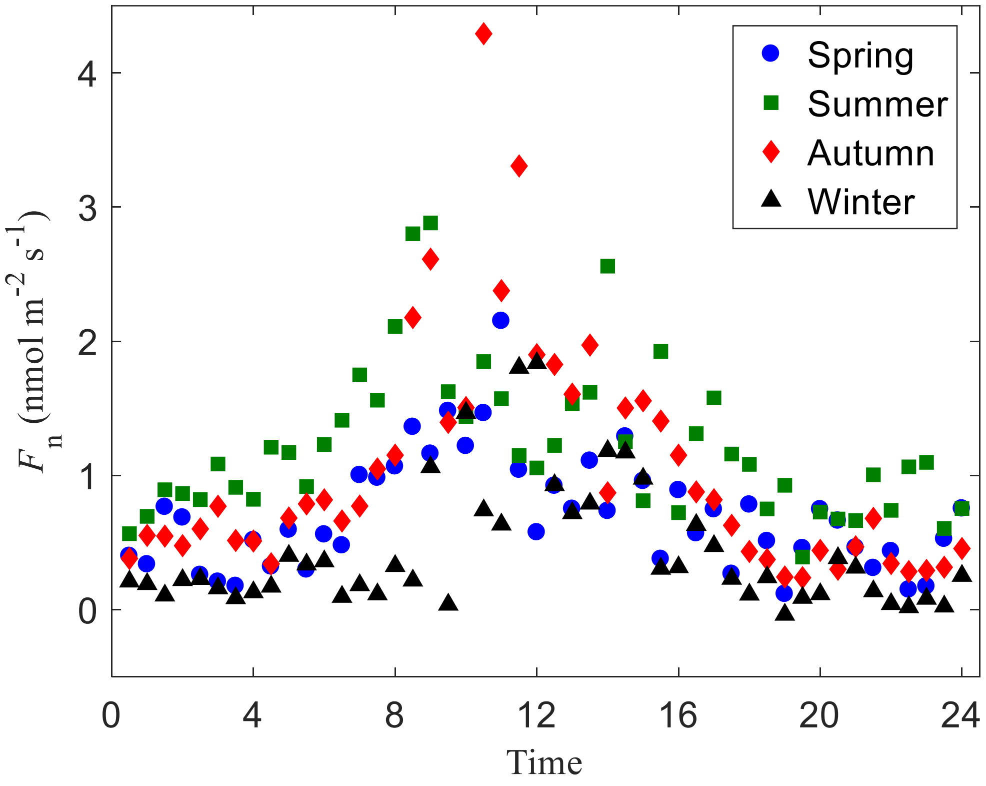


Main land use types: cropland and water body

N_2O flux measurement: half-hourly scale



N_2O flux measurement: diurnal component

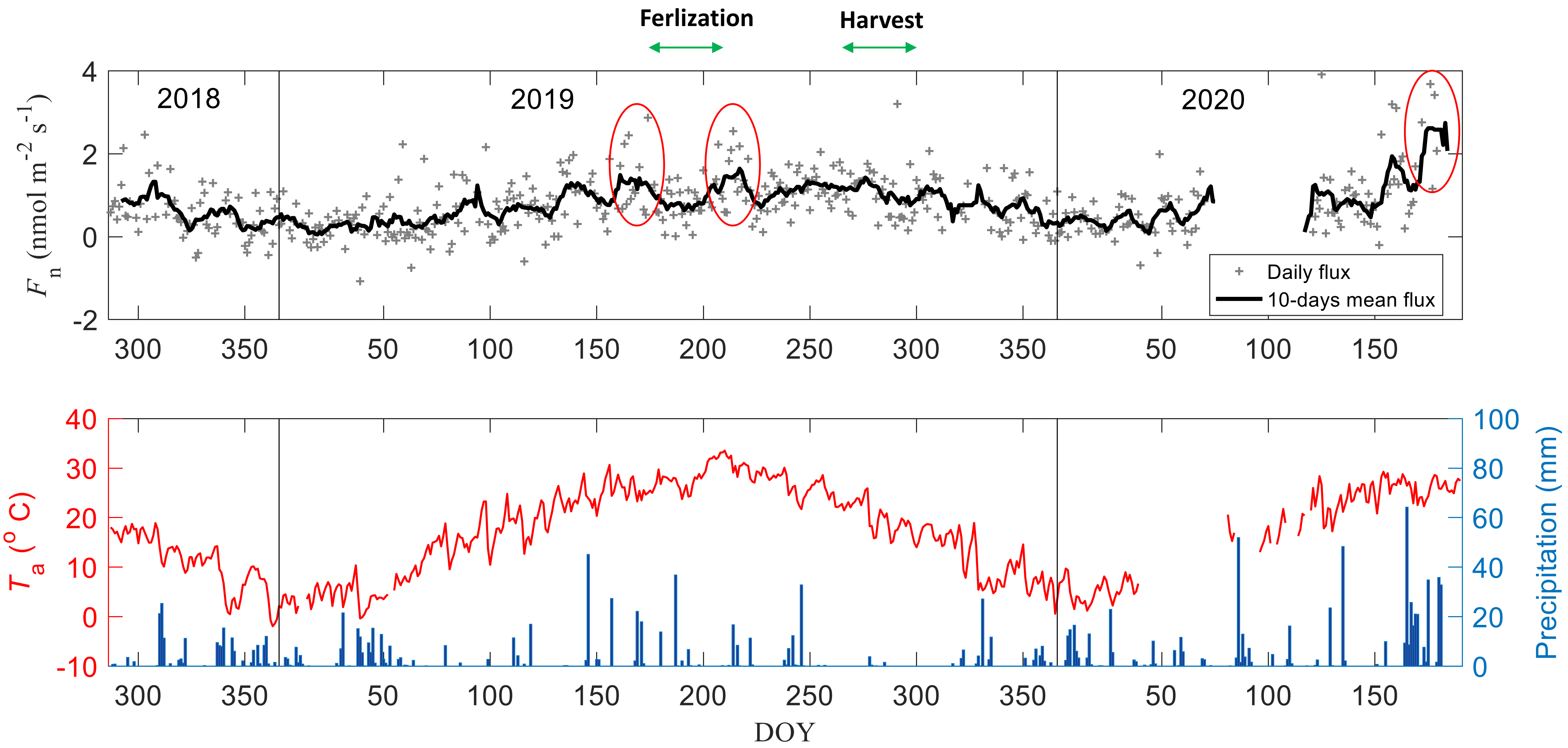


Daytime > Nighttime

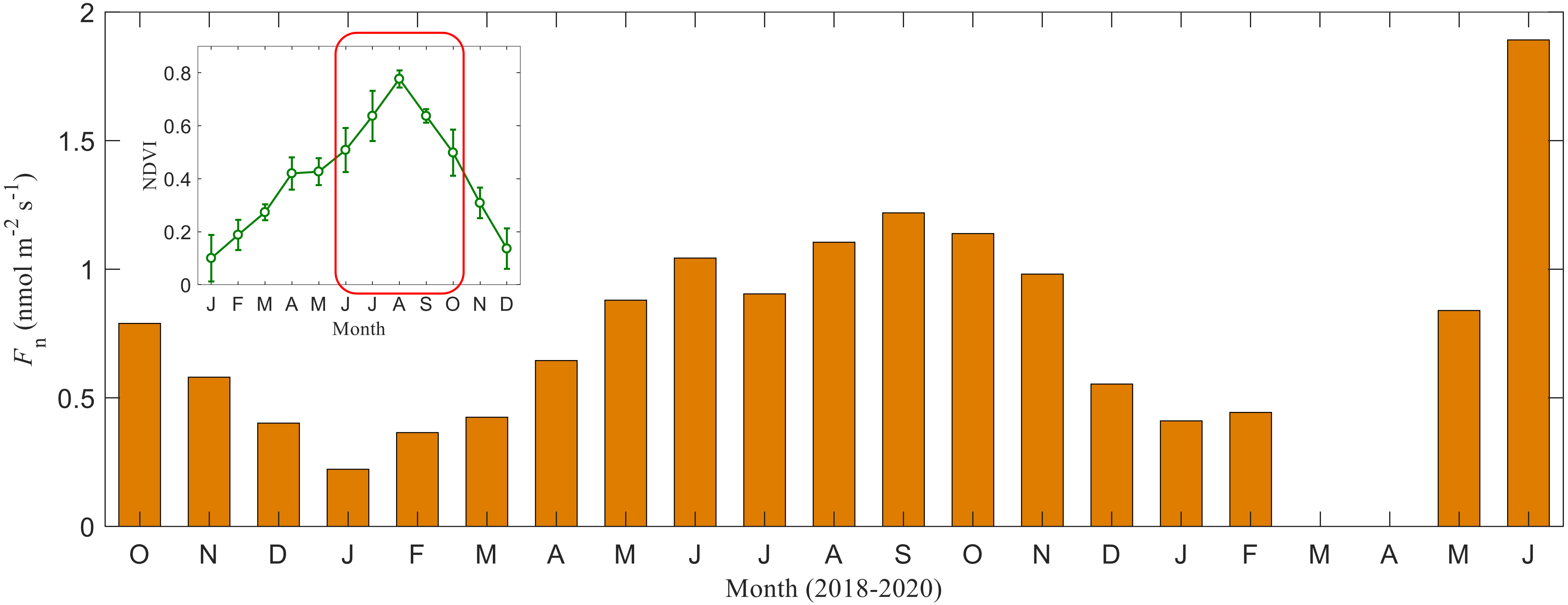
	Spring	Summer	Autumn	Winter	Total
Daytime	0.93 ± 3.59	1.48 ± 3.91	1.63 ± 4.18	0.74 ± 3.42	1.16 ± 3.78[a]
Nighttime	0.43 ± 1.85	0.84 ± 1.93	0.47 ± 1.31	0.17 ± 1.28	0.43 ± 1.58[b]

Note: different letters denote significant differences.

N_2O flux measurement: daily scale

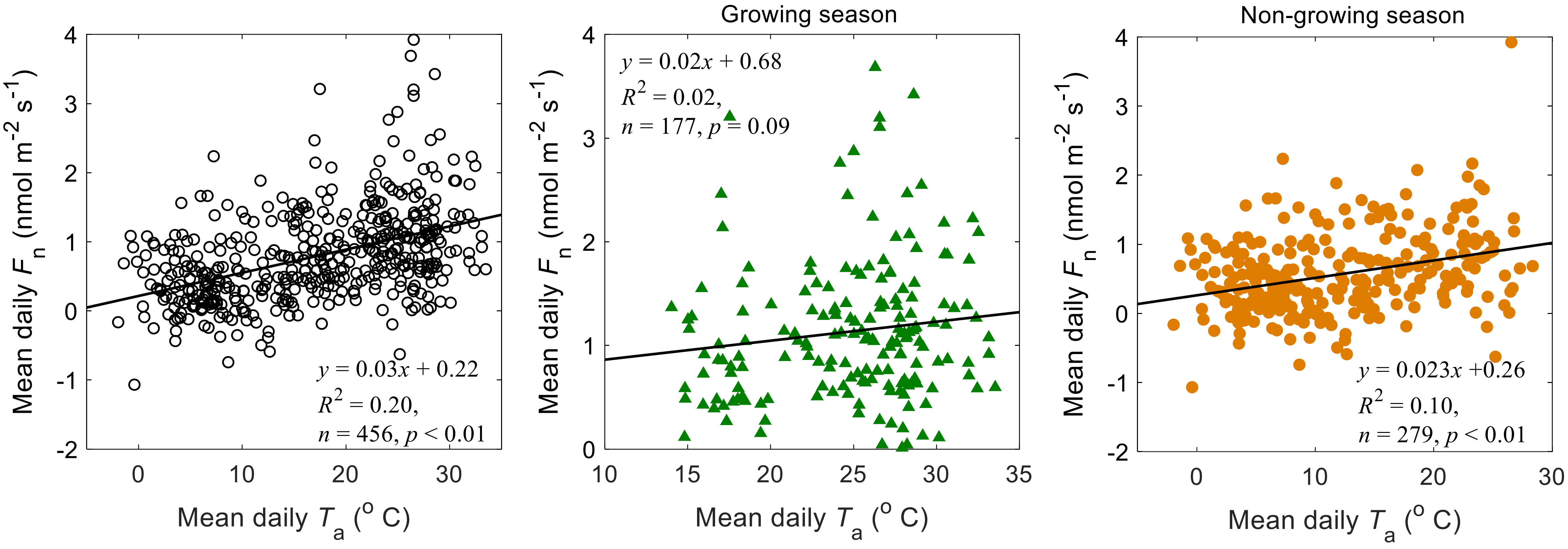


N_2O flux measurement: monthly scale

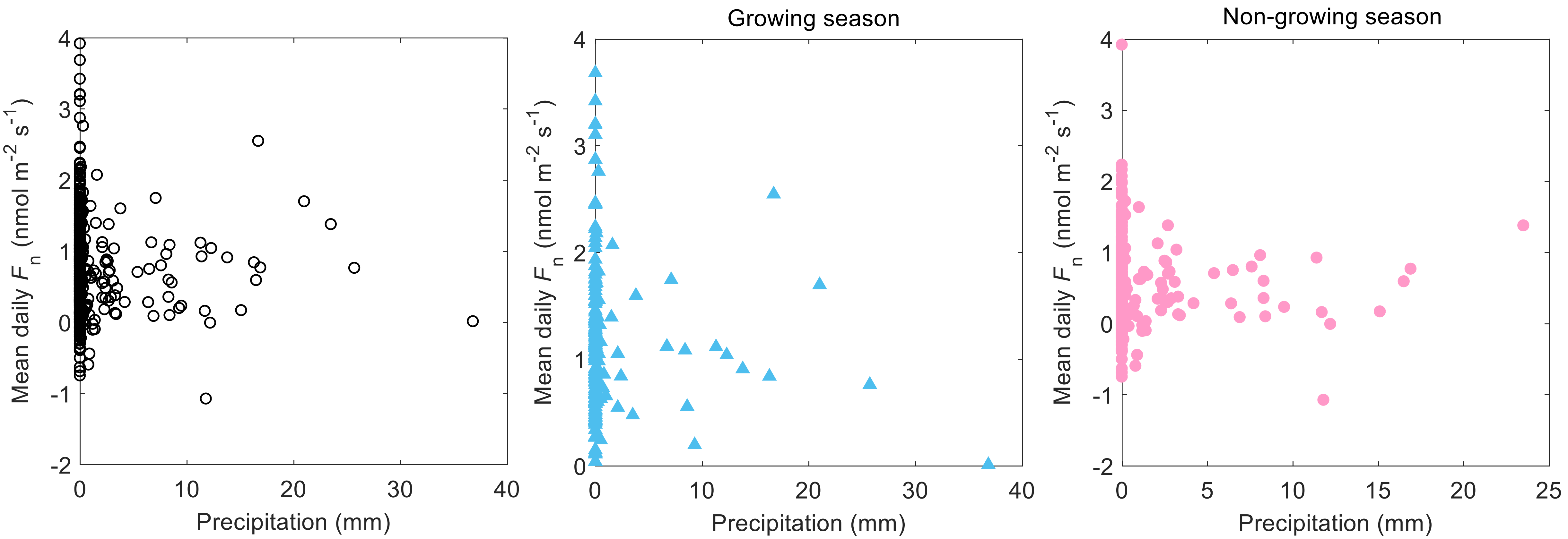


	Growing season	Non-growing season
F_n (nmol m^{-2} s^{-1})	1.15 ± 3.13	0.55 ± 2.65

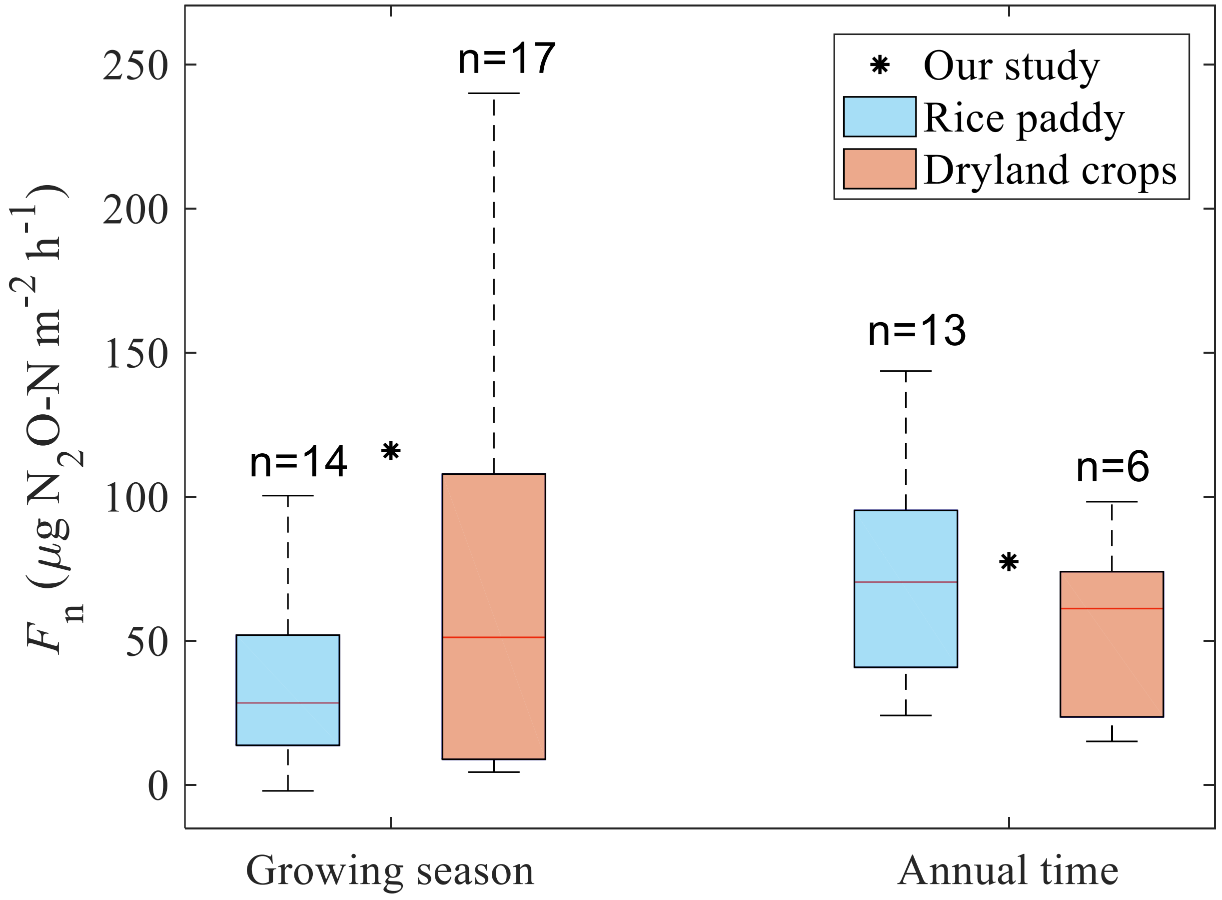
Environmental factors on N_2O flux: air temperature



Environmental factors on N_2O flux: precipitation



Comparison with other literatures



Conclusions

- During the measurement period (Oct. 2018 – Jul. 2020), N_2O flux ranged from -1.07 to 3.92 nmol m^{-2} s^{-1}, with mean value of 0.77 ± 0.68 nmol m^{-2} s^{-1} on daily scale.

- N_2O flux in growing season (1.15 ± 3.13 nmol m^{-2} s^{-1}) was higher than that in non-growing season (0.55 ± 2.65 nmol m^{-2} s^{-1}), and it accounted for 67% of the total flux.

- There was no relation bewteen N_2O flux and T_a in growing season, but a weak positive relation in non-growing season. And precipitation had greater influence on N_2O 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!