Effects of Temperature increasing on the N_2O Emission from Intertidal Area along the East China Coast

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Why Intertidal Zone?

- Intertidal zones act as the carbon sink to capture the atmospheric carbon---blue carbon.
- Global changes, such as temperature increasing and sea level rising, would affect carbon and nitrogen biogeochemical cycling in this area.

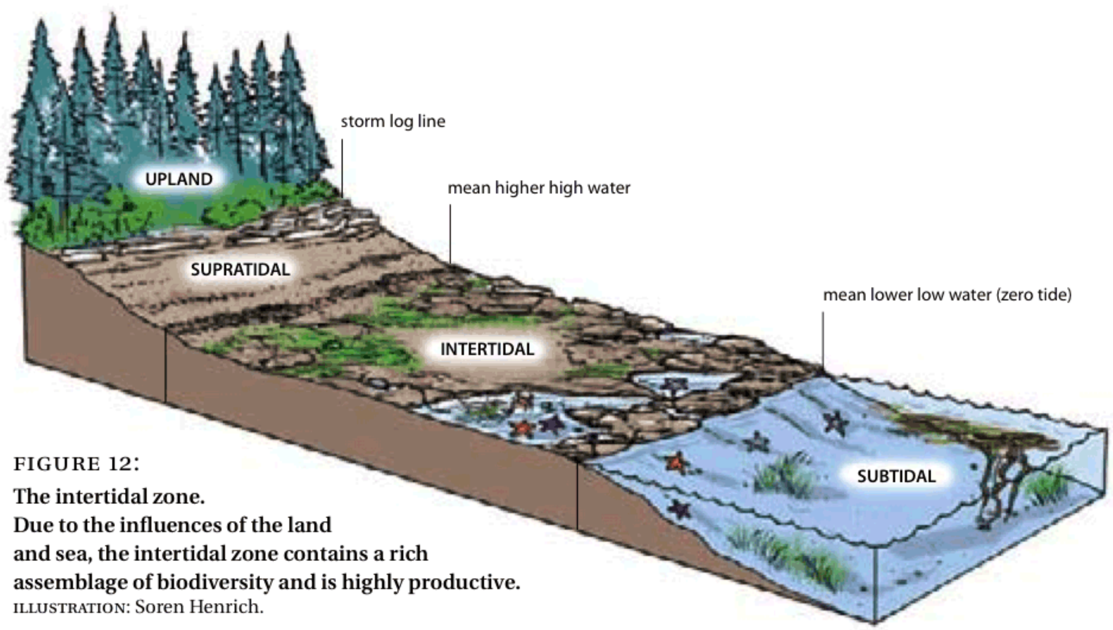
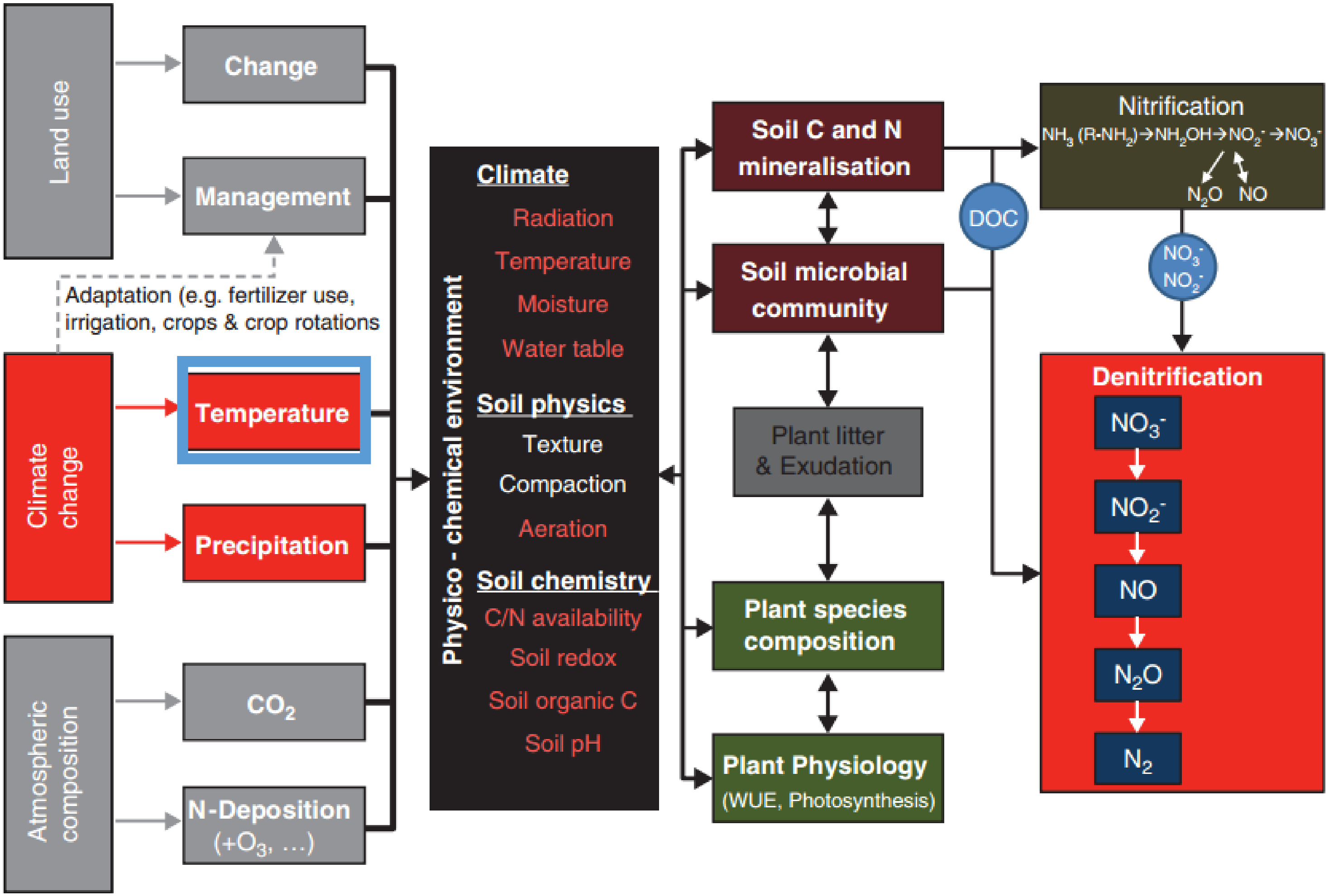


FIGURE 12:
The intertidal zone.
Due to the influences of the land and sea, the intertidal zone contains a rich assemblage of biodiversity and is highly productive.
ILLUSTRATION: Soren Henrich.

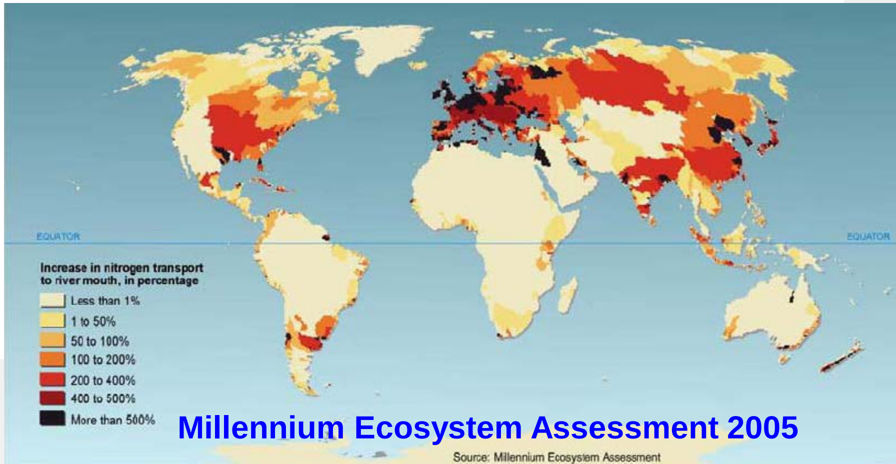
Why Temperature controlling?



Butterbach-Bahl and Dannenmann 2011, Current Opinion in Environmental Sustainability

Why Nitrous Oxide (N_2O) ?

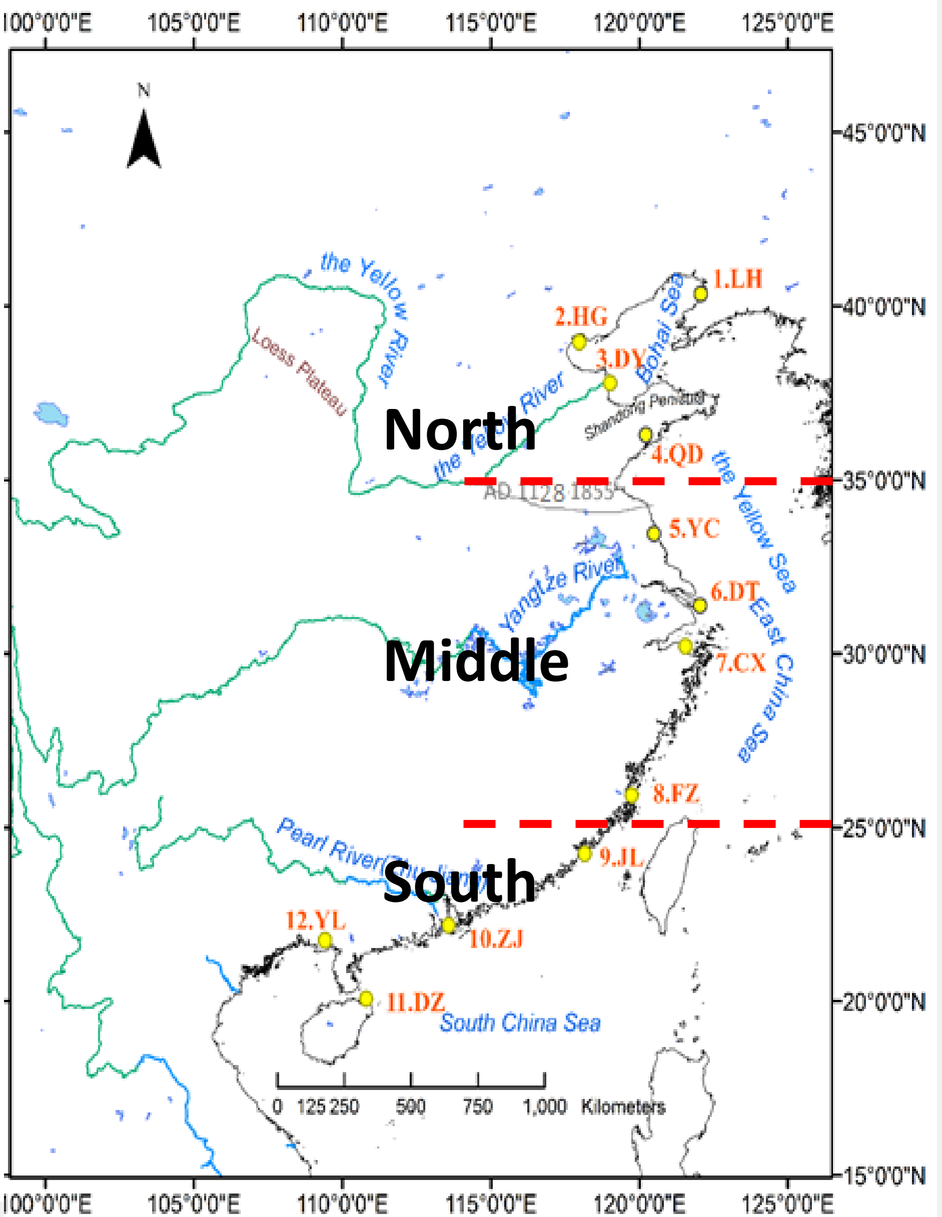
- N_2O contributed amount to 80% of the total radiative forcing with CO_2 and CH_4 altogether (Chapter 8, IPCC 2013), with a **100-year** global warming potential 298 times that of CO_2.
- N_2O increased by 20% from **271** ppb pre-industrial to **324** ppb in 2011. (Chapter 6, IPCC 2013)
- The NO and NO_2 (NO_Y) resulting from N_2O **destroys ozone** (O_3).
- Intertidal zone would be a potential source of N_2O emission because of the activity nitrogen concentration increasing in Estuaries and Coasts.



Millennium Ecosystem Assessment 2005

Study area

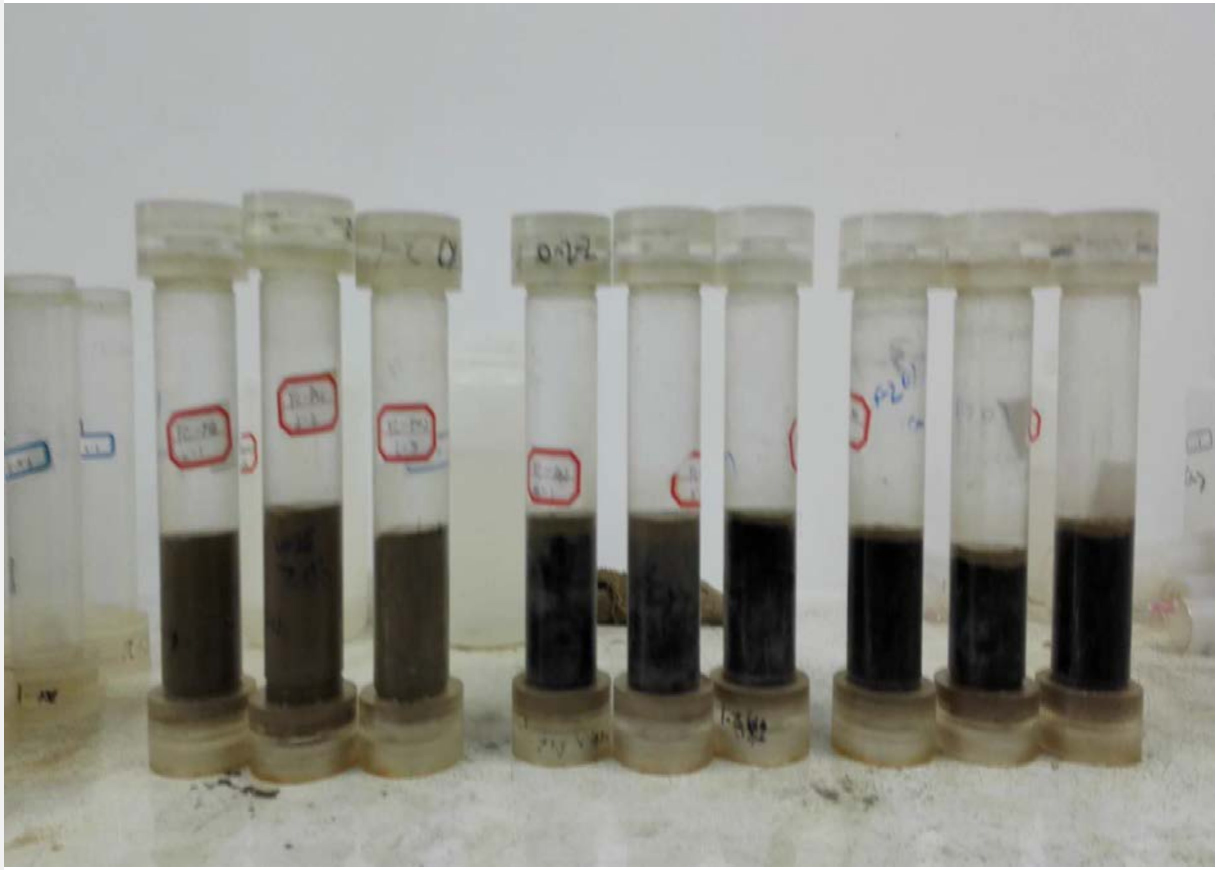
- The East China Coast (ECC) has an **1800km** long coastline, which stretching across tropical, subtropical and temperate zones.
- Twelve sites at main estuaries along the ECC.



- This research try to investigate how increasing temperature affects the N_2O emissions along the East China Coast using incubation method.

- (1) Does the amount of fluxes tested by incubation method reliable? —— **YES!**
- (2) How does the flooding affects the N_2O flux? —— **UNLIKELY.**
- (3) What does the influence of increasing temperature on N_2O flux? —— **VARIABLE.**
- (4) What is the latitude-temperature pattern of N_2O flux? —— **INTERESTING.**
- (5) Do we find precise reason for the trend of N_2O flux? —— **DIFFICULT.**

(1) Does the amount of fluxes tested by incubation method reliable? —— Yes!



Three duplicate samples of each sampling sites.

Continuous incubation temperature of 15℃, 25℃ and 35℃.

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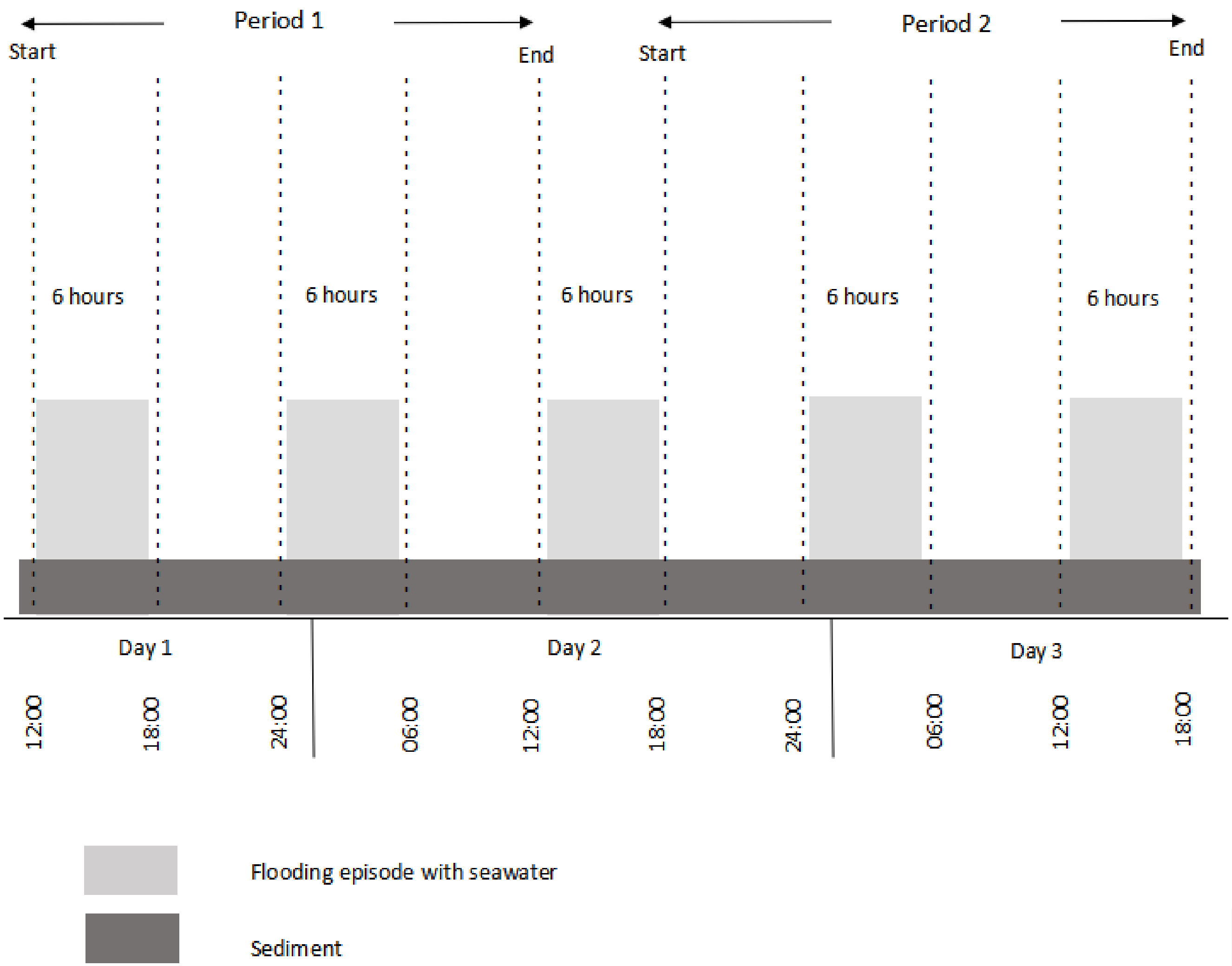
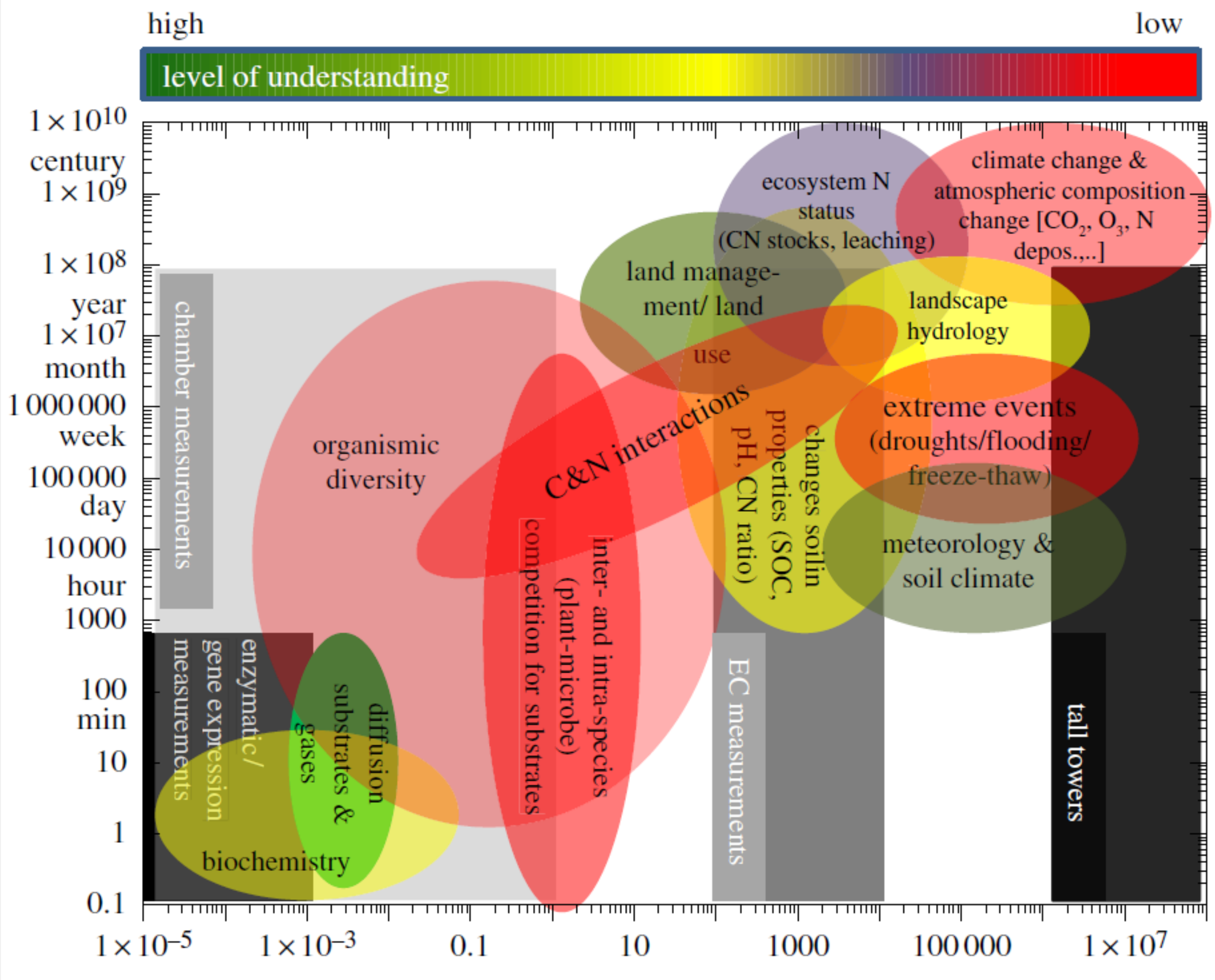


Artificial seawater (in site salinity and 2mg NO_3^--N/L, 0.5mg NH_4^+-N/L)

Regular semi-diurnal tidal flooding pattern.

(1) Does the amount of fluxes tested by incubation method reliable?—— Yes!



Butterbach-Bahl et al, 2013 Phii. Trans. Roy. Soc

Advantages:

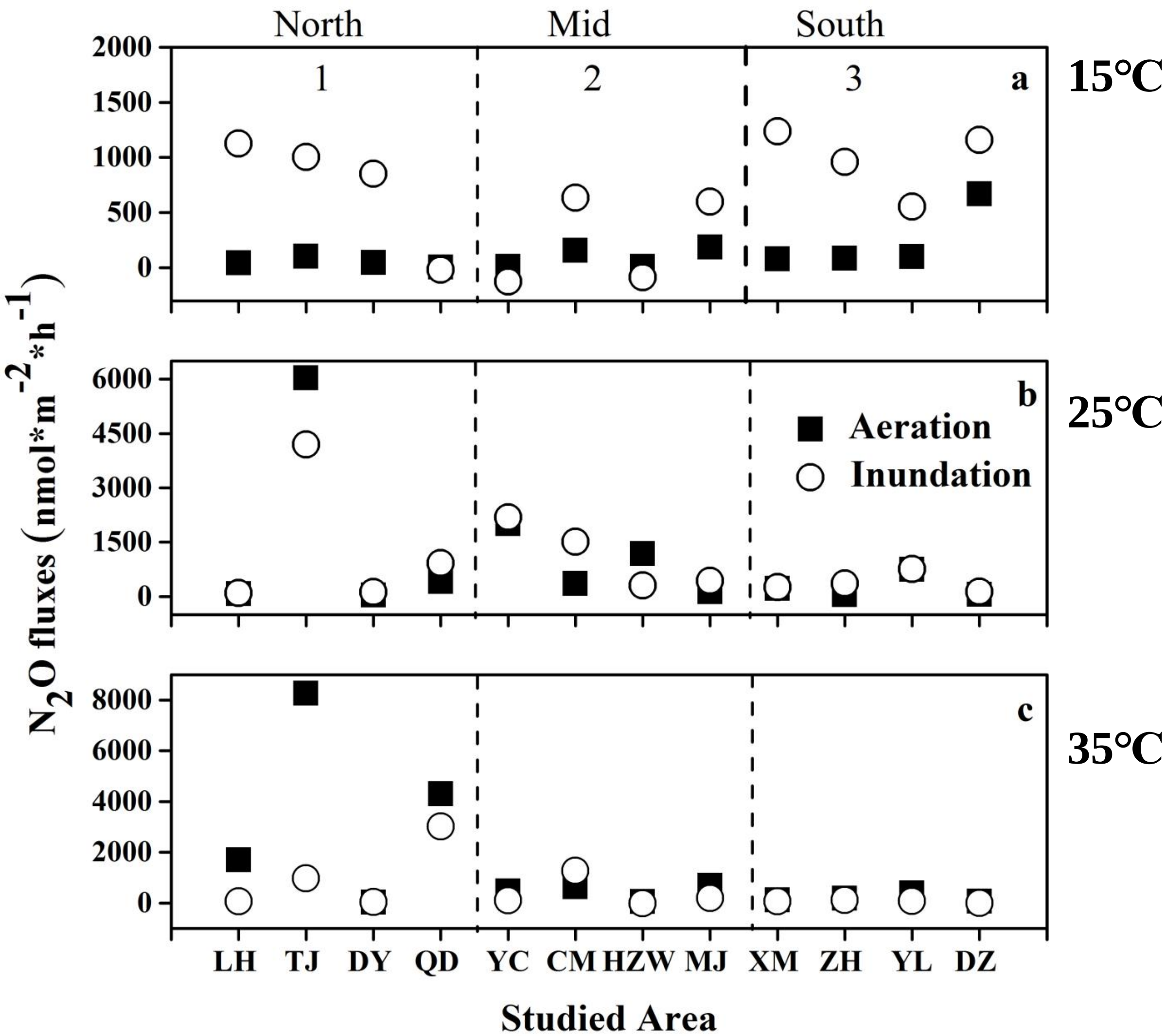
Large-scale (compared with chamber measurement)

Easy to control (like controlling temperature and flooding pattern in this study)

Disadvantages:

It is difficult to simulate a real coastal environment.

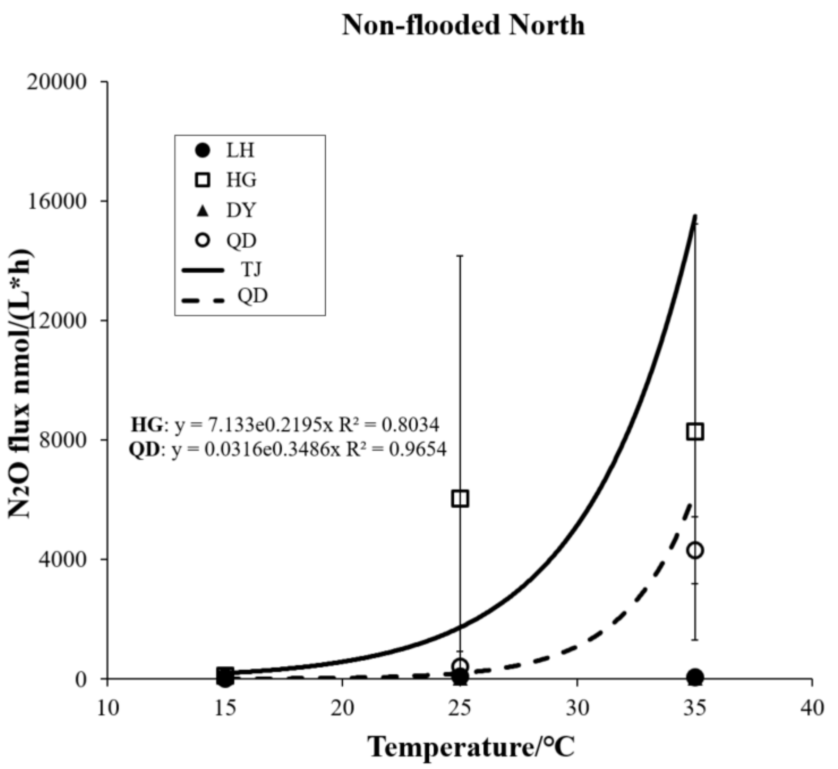
(2) How does the flooding affects the N_2O flux?
—— UNLIKELY.

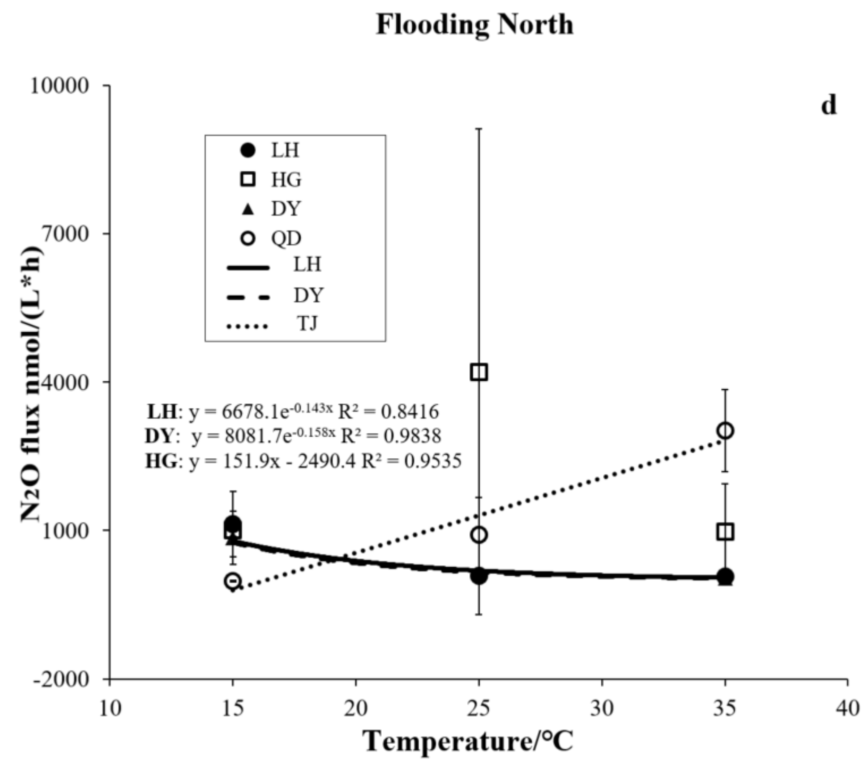


❖At 15℃, flooding recharged nitrogen for N_2O production.

❖With increasing temperature, flooding trapped the N_2O in sediment cores, more N_2O transformed into N_2.

(3) What does the influence of increasing temperature on N_2O flux? —— VARIABLE.





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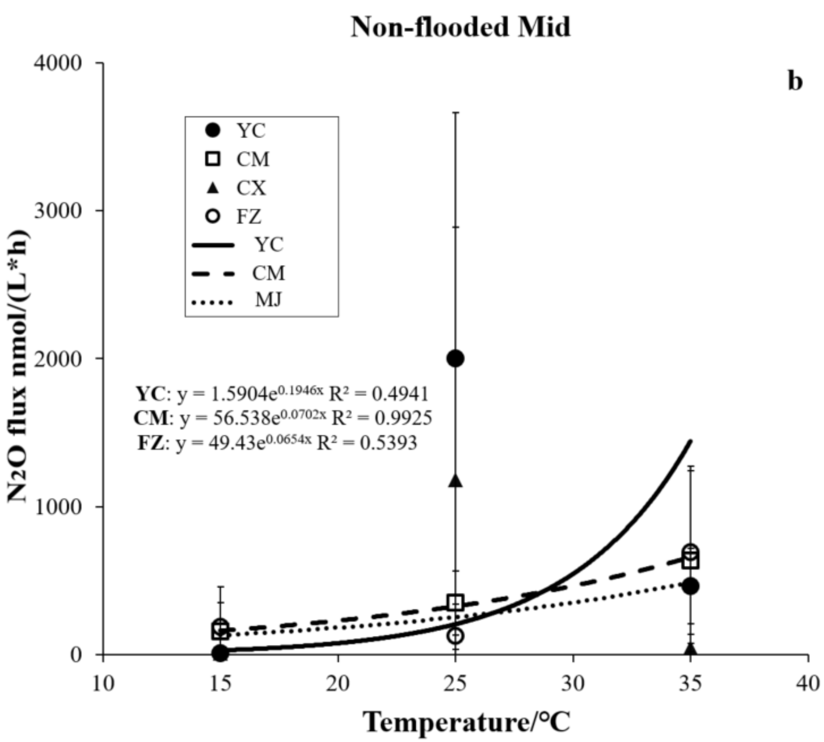

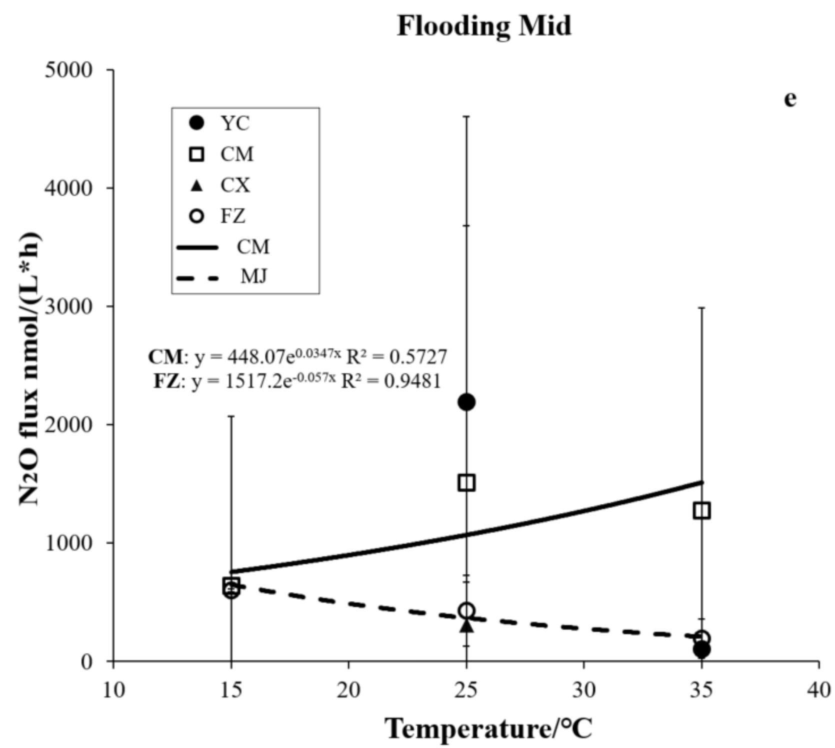

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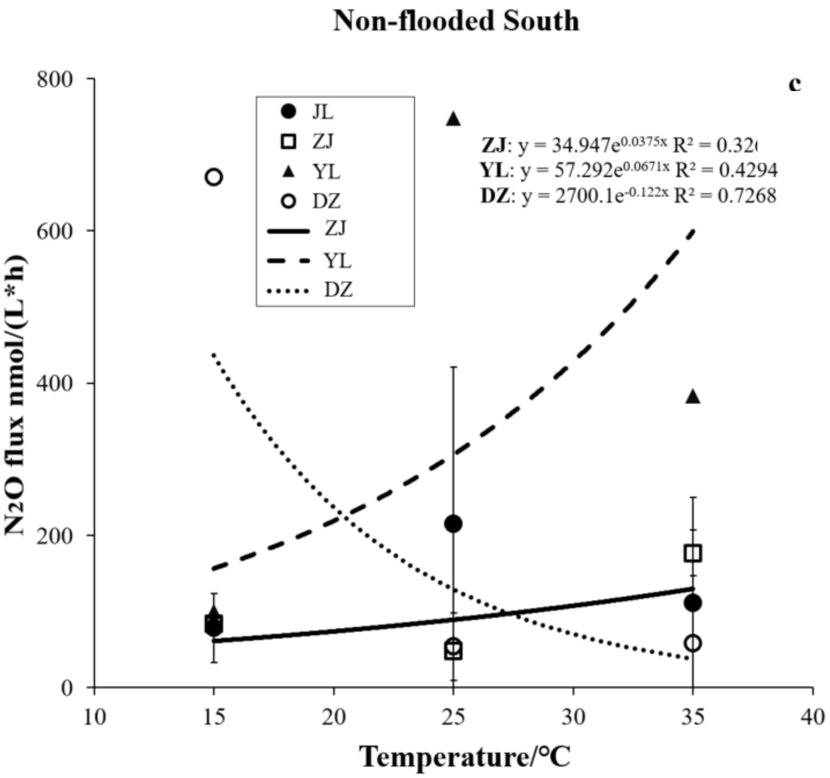
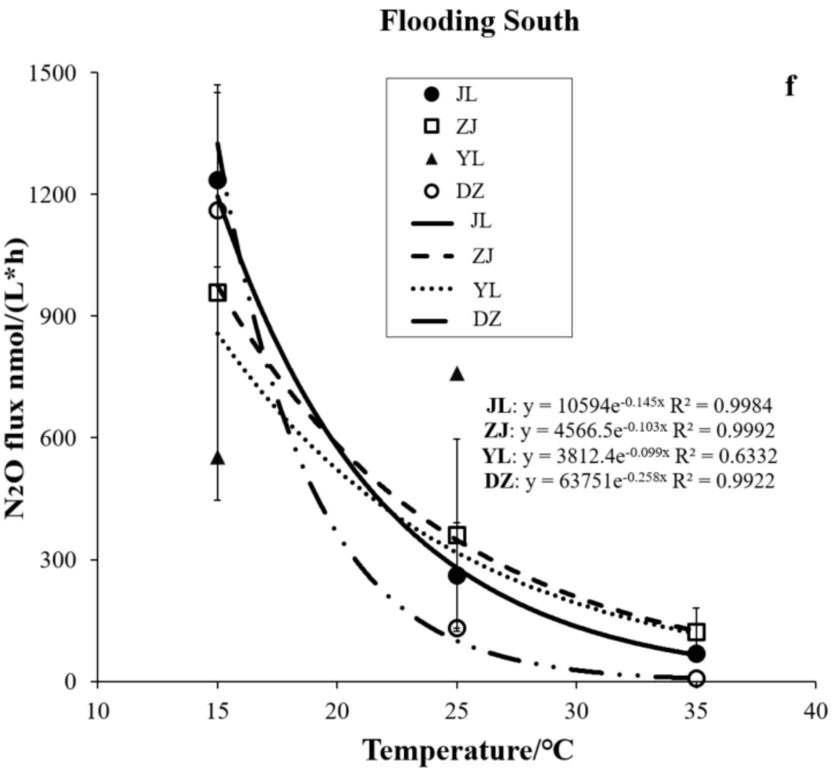
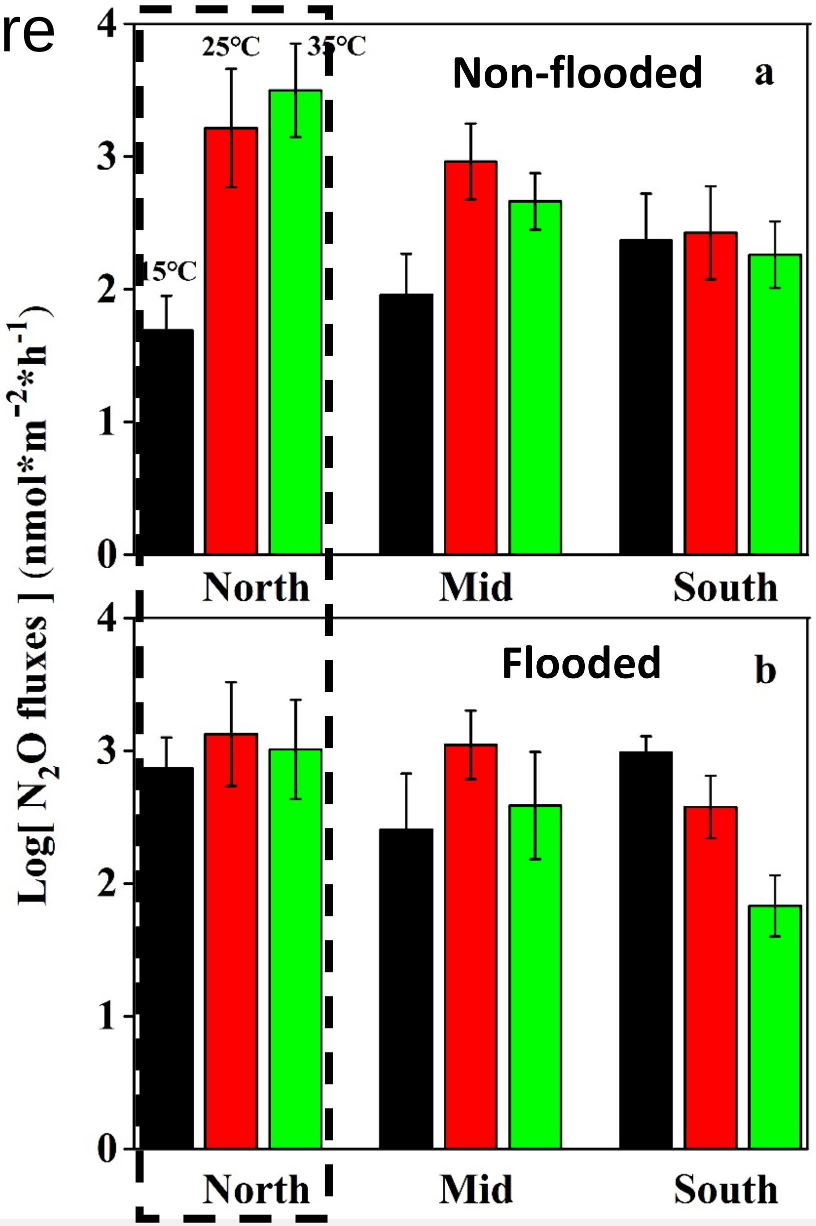




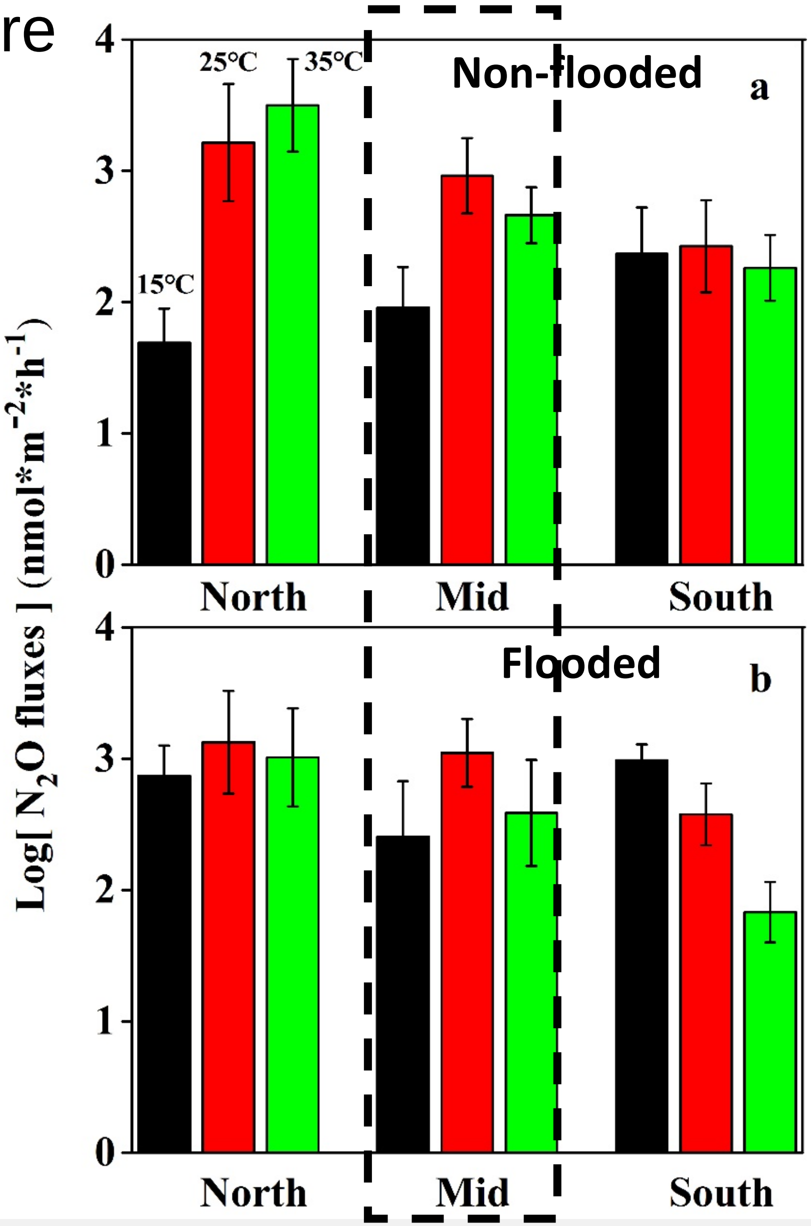
(4) What is the latitude-temperature pattern of N_2O flux? —— INTERESTING.

❖ Northern N_2O flux exhibited **significant increase** with temperature during non-flooding.



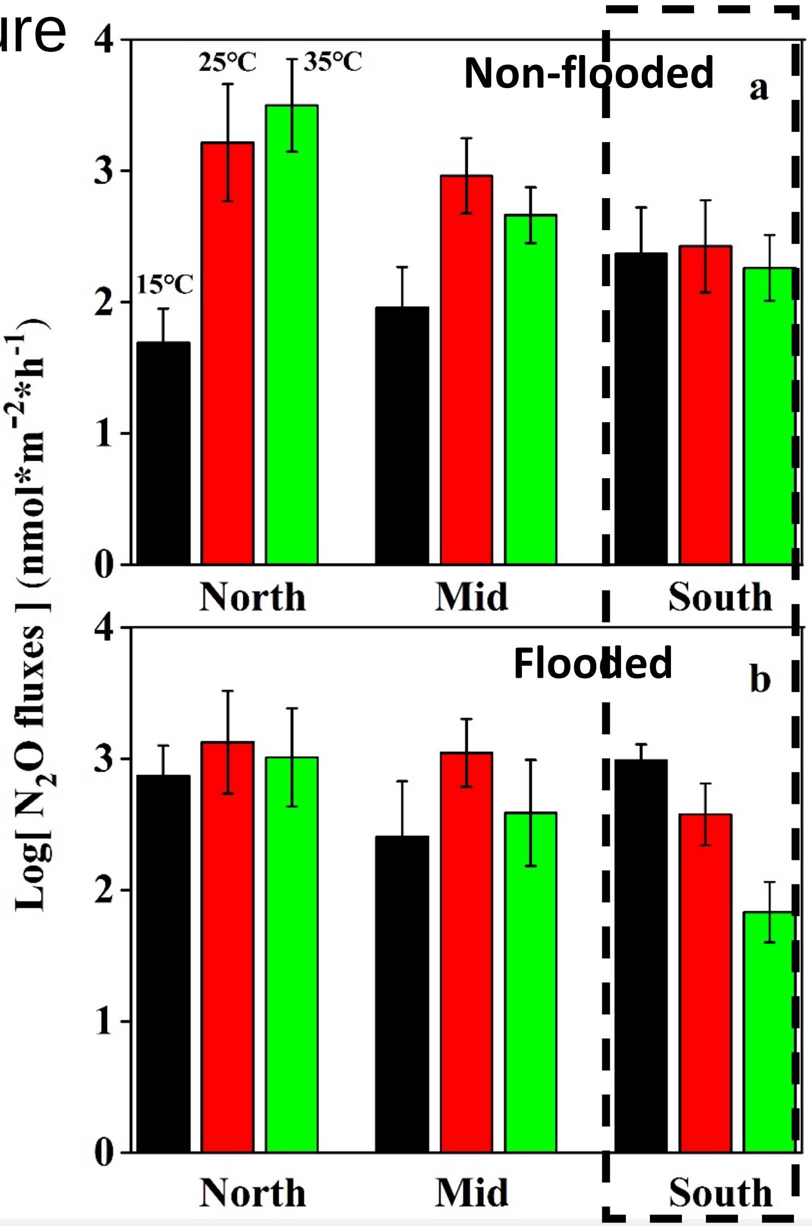
(4) What is the latitude-temperature pattern of N_2O flux? —— INTERESTING.

❖Almost Mid subareas reached the **highest** N_2O flux at **25℃**.

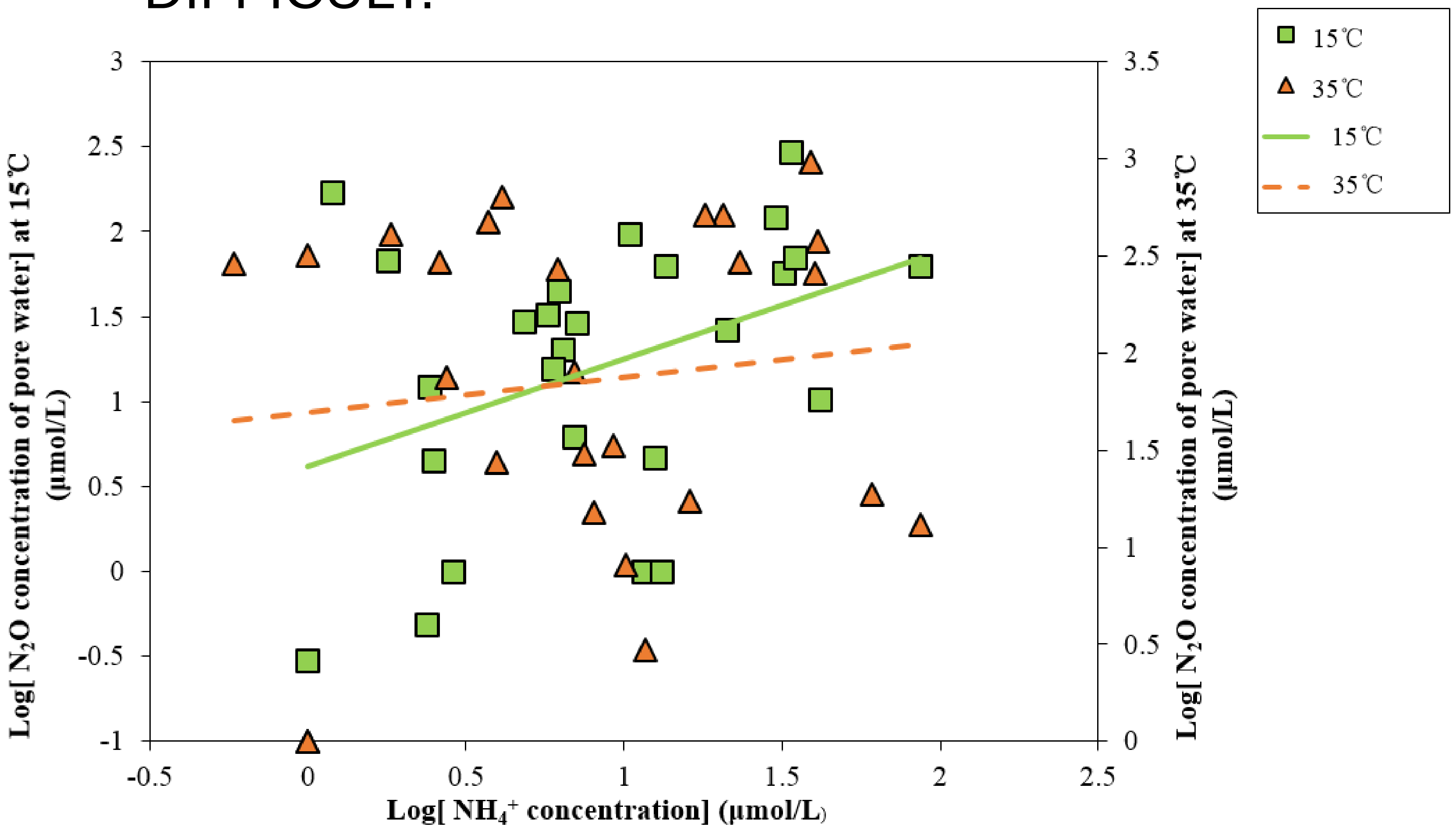


(4) What is the latitude-temperature pattern of N_2O flux? —— INTERESTING.

❖ N_2O flux of South soil **exponential decline** with increasing temperature during flooding.



(5) Do we find precise reason for the trend of N_2O flux?
—— DIFFICULT.



❖**Nitrification** and **coupled nitrification-denitrification** drive N_2O evolution across all coastal soils.

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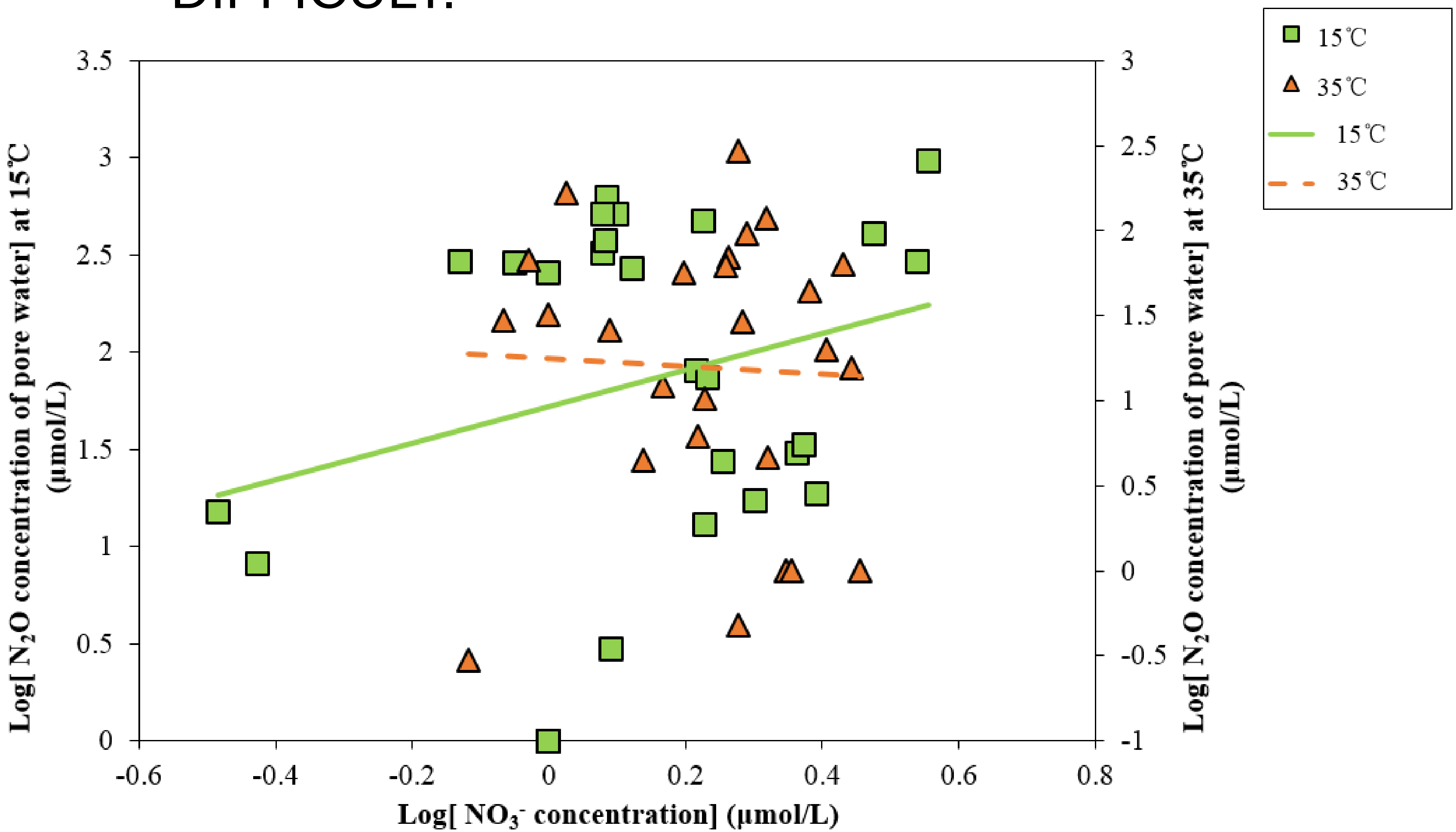


❖**Denitrification** also contributes to N_2O emission at 15°C.

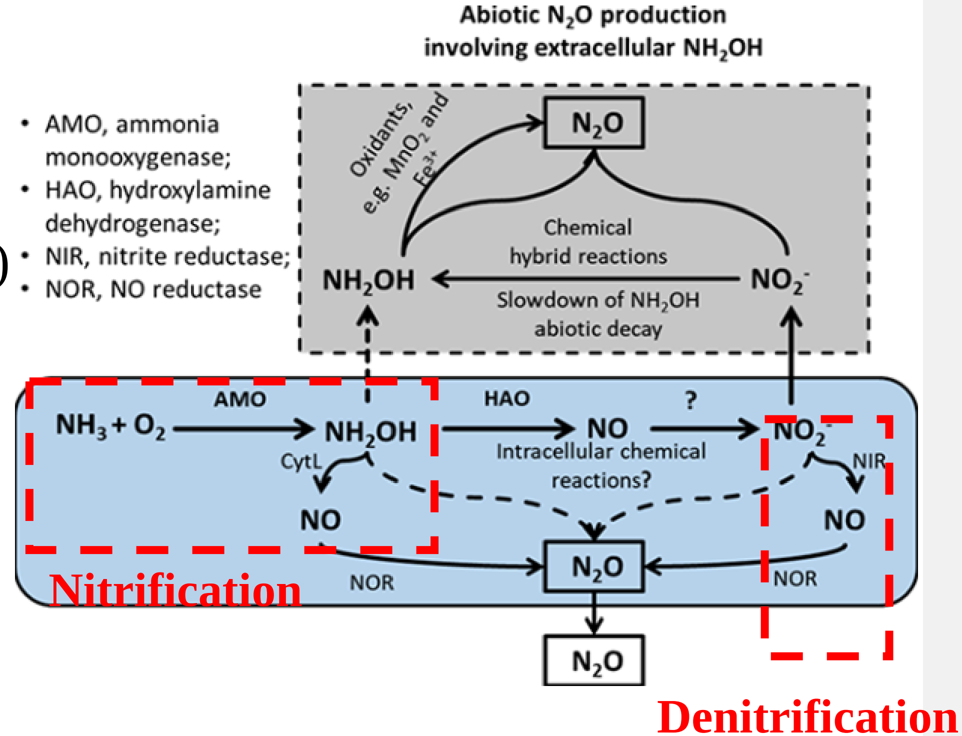
(5) Do we find precise reason for the trend of N_2O flux? —— DIFFICULT.

❖**Nitrification:**

AMO（Ammonia Monooxygenase）catalyze the oxidation of ammonia, which is encoded by **amoA genes** both from archaeal ammonia oxidizers (**AOA**) and bacterial ammonia oxidizers (**AOB**).

❖**Denitrification:**

Nitrate reductase (NIR) reduce NO_2^- /NO_3^- to N_2O , which encoded by **nirK gene** and **nirS gene** of copper containing nitrite reductases and cytochrome cd_1 nitrate reductases respectively.



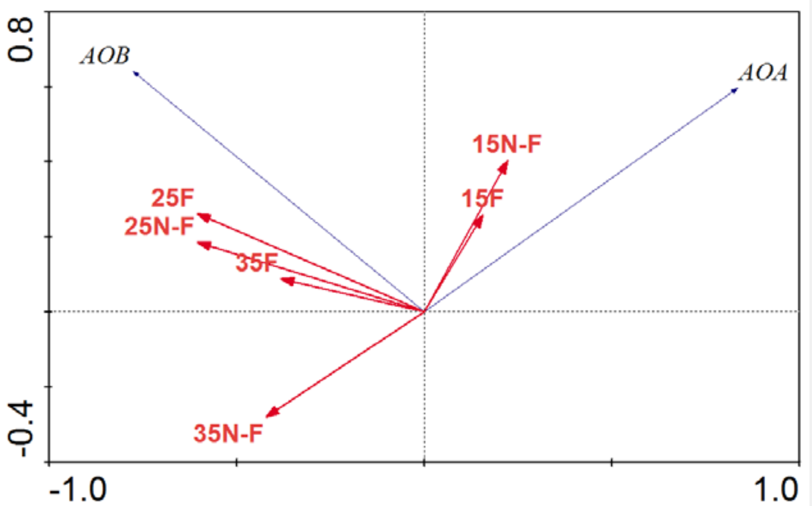
Liu S 2017, Environmental Science& Technology

(5) Do we find precise reason for the trend of N_2O flux? —— DIFFICULT.

❖Methods:

(1) **qPCR**——the amount of genes

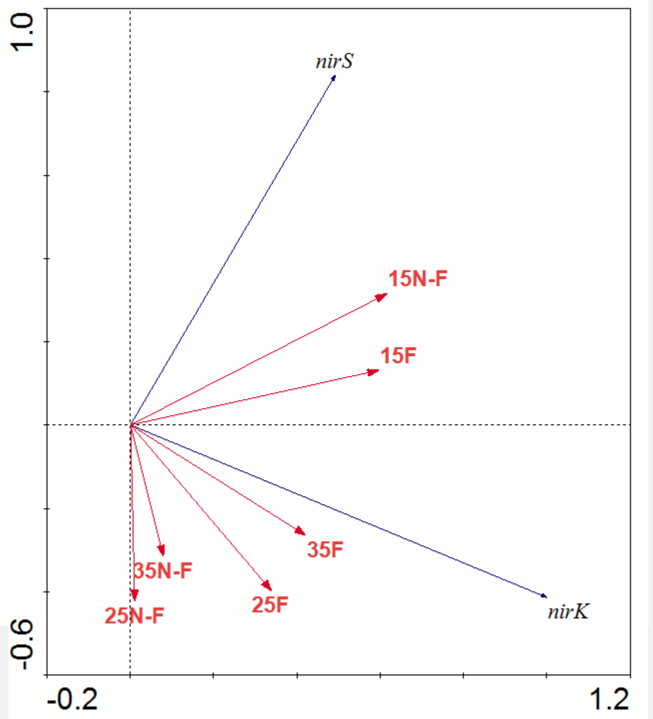
(2)**RDA analysis**——correlations between genes with N_2O fluxes



❖RDA results:

(1)Positive correlation between fluxes at 15°C with AOA-amoA and NirS genes.

(2)Positive correlation between fluxes at 25°C and 35°C with AOB-amoA and nirK genes.



Conclusion

❖Temperature increasing would stimulate N_2O emission from high latitude intertidal area especially during ebb tide, while would decrease the emission from low latitude.

❖There is a lots of work to confirm and quantity the effect of environmental factors on N_2O emission, so hard to accurately model it emission under global change.

Thanks!

Any questions?