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Different composting modes shape specific AOB and nirK-type denitrifiers correlated with N_2O emissions

TAO JIANG

LESHAN NORMAL UNIVERSITY

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Project partner

Guoxue Li

China Agricultural University

Tao Jiang

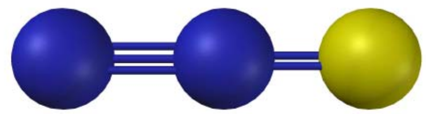
Leshan Normal University

Jiali Chang

Leshan Normal University

Background

N_2O in the air



- N_2O is an important greenhouse gas.
- N_2O content in the air increased 20% in the last 50 years
- N_2O is considered to be an important factor in ozone depletion.

GWP data was changed in IPCC Climate Change 2014-Synthesis Report

		GWP		GTP	
	Lifetime(yr)	Cumulative forcing over 20 yr	Cumulative forcing over 100 yr	Temperature change after 20 yr	Temperature change after 100 yr
CO_2		1	1	1	1
CH_4	12.4	84	28	67	4
N_2O	121	264	265	277	234
CF_4	50,000	4880	6630	5270	8040

(IPCC, 2014; Ravishankara et al., 2009; Mosier et al.,1998; Houghton et al., 2001)

Background

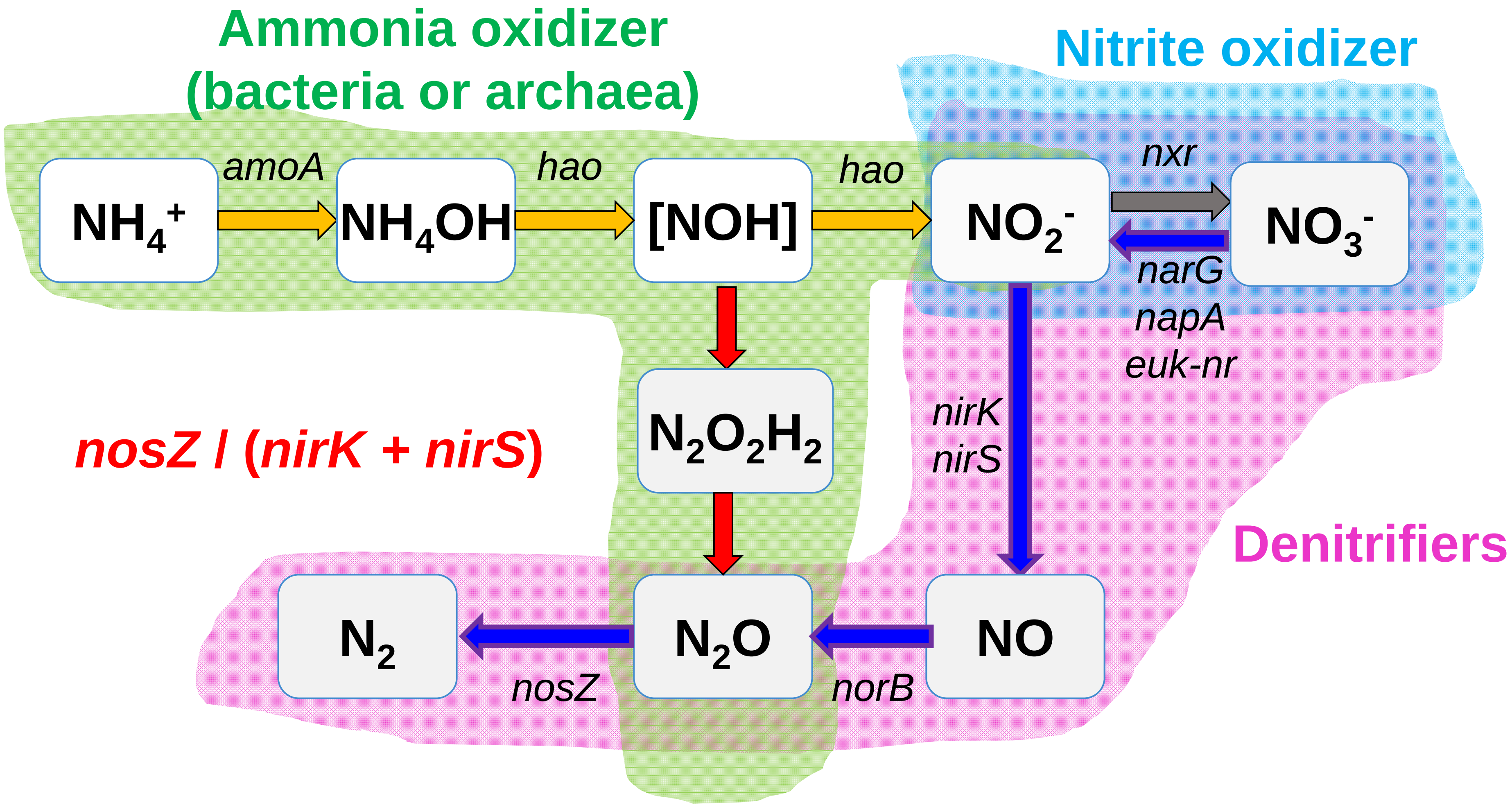
N_2O emission in agriculture

- More than **80%** N_2O emitted from agriculture, including manure management, synthetic fertilizer and manure application / deposition.
- Composting is one of the significant sources of N_2O production, which accounts for approximately **30-50%** of the annual global N_2O emissions from agriculture
- When the compost was normally operated, N_2O emission account for **0.2-3.0%** of total nitrogen that was about **26-61 kg CO_2 eq/t** manure.

(IPCC, 2014; USEPA，2011；FAOSTAT，2013)

Background

N_2O production by microorganisms



(Canfield, 2010; Madae et al., 2011; Angnes et al., 2013; Li et al., 2017; Bian et al., 2017)

Scientific problem

What about the microbial community structure relationship with N_2O emissions during composting.

Materials and methods

Raw materials

- <u>Cornstalk</u>

  air dried and chopped to ~ 5 -10 cm;

- <u>Pig faeces</u>

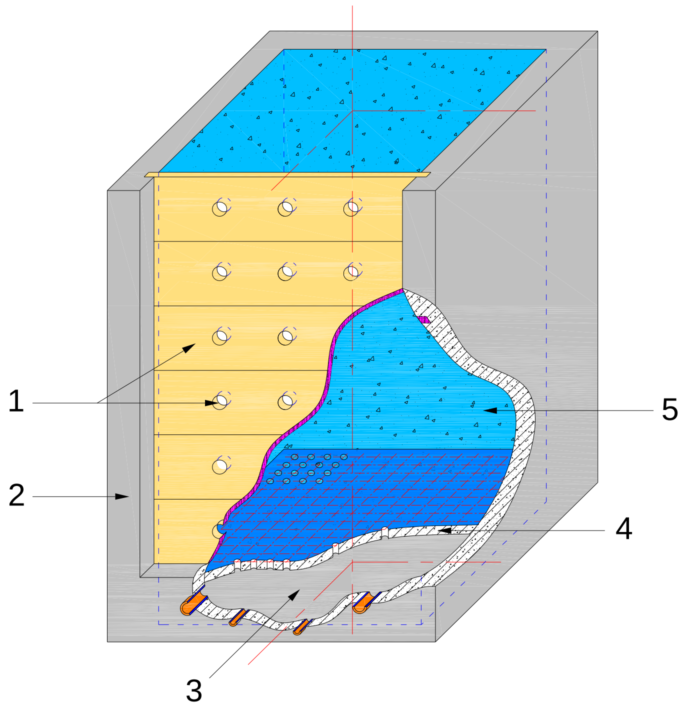
  from Ganqingfen system of a local pig farm.

Samples	TOC ($g \cdot kg^{-1}$)	TN ($g \cdot kg^{-1}$)	Ammonium ($g \cdot kg^{-1}$)	Moisture content (%)	C/N
Pig faeces	343.7	26.5	7.4	71.8	13.0
Cornstalk	419.0	9.9	—	9.3	42.3
Mixture	367.4	21.2	5.7	63.6	17.3

Materials and methods

Composting methods

- Materials were composted in 1.2 m^3 bins for 10 week.
- Total 3 treatments:
  Static, Turn, Forced aeration.
- Turning frequency is 1/week.
- Aeration rate is 0.25 $L \cdot kgDM^{-1} \cdot min^{-1}$.

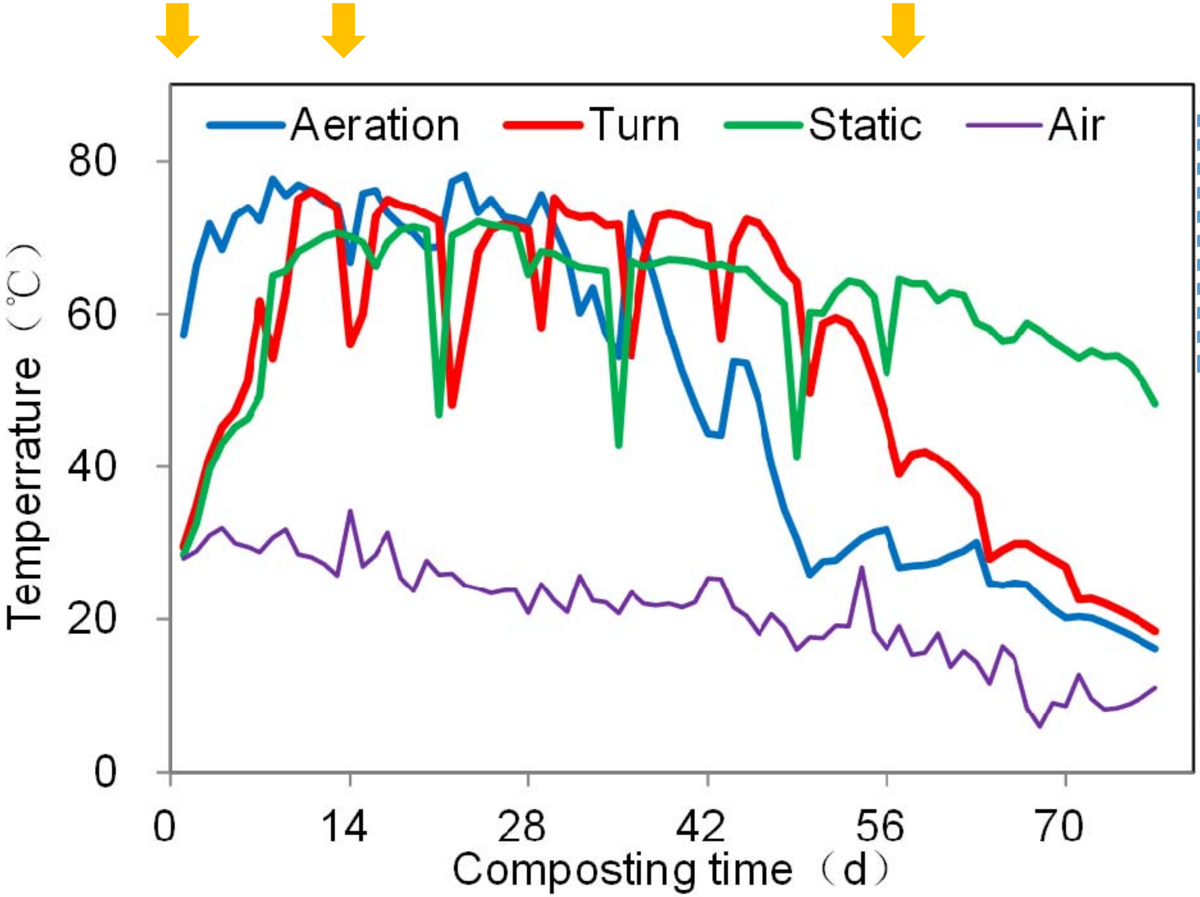


1. Wooden boards with sampling holes;
2. Concrete side wall;
3. Concrete floor and aeration and leachate cavum;
4. Bottom board with aeration holes;
5. Compost materials.

T, pH, O_2, ORP, N_2O, NH_4^+, NO_3^-

Materials and methods

Sampling for microbial analysis



amoA gene

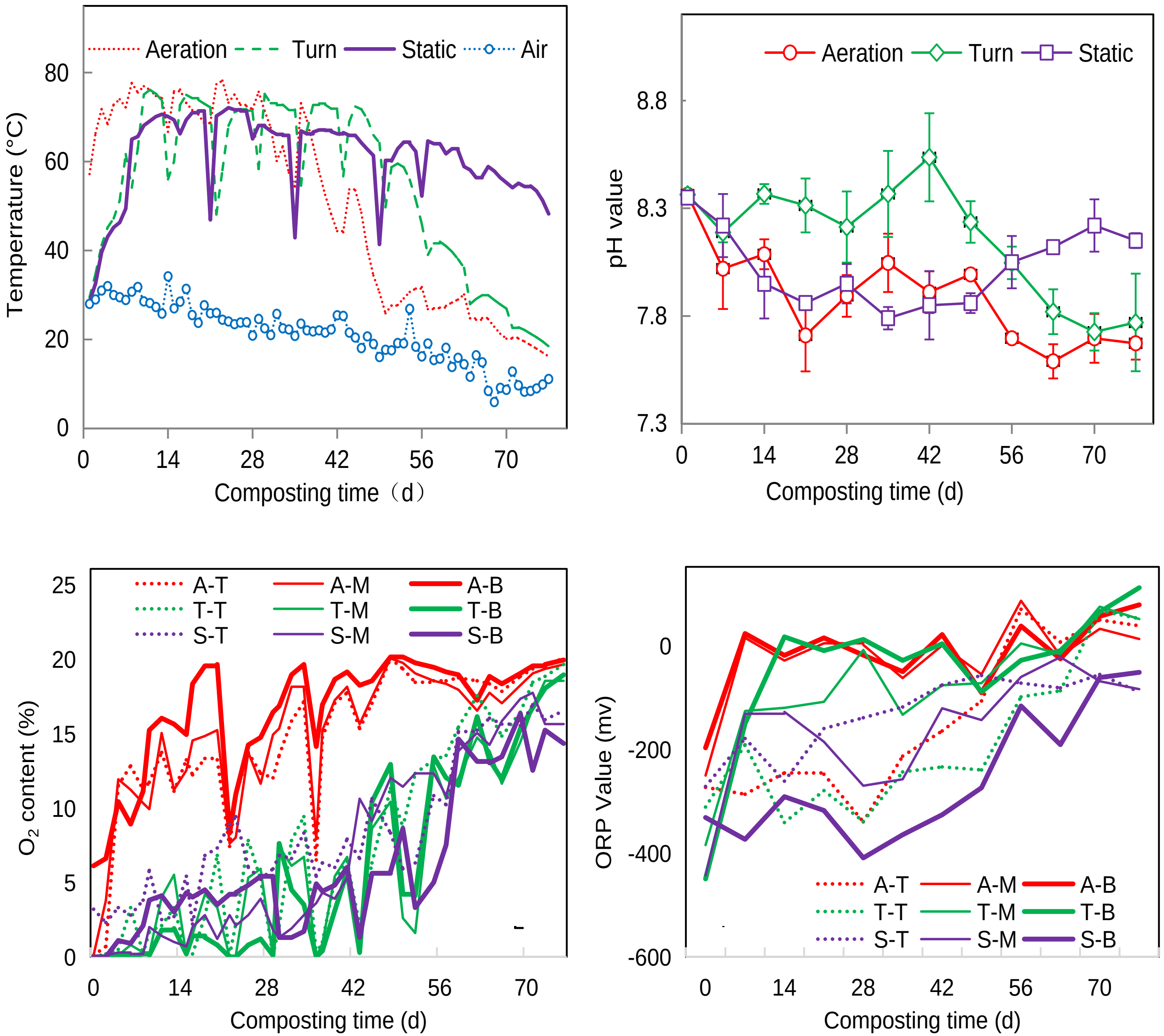
Ammonia oxidizer (bacteria or archaea)

nirK gene

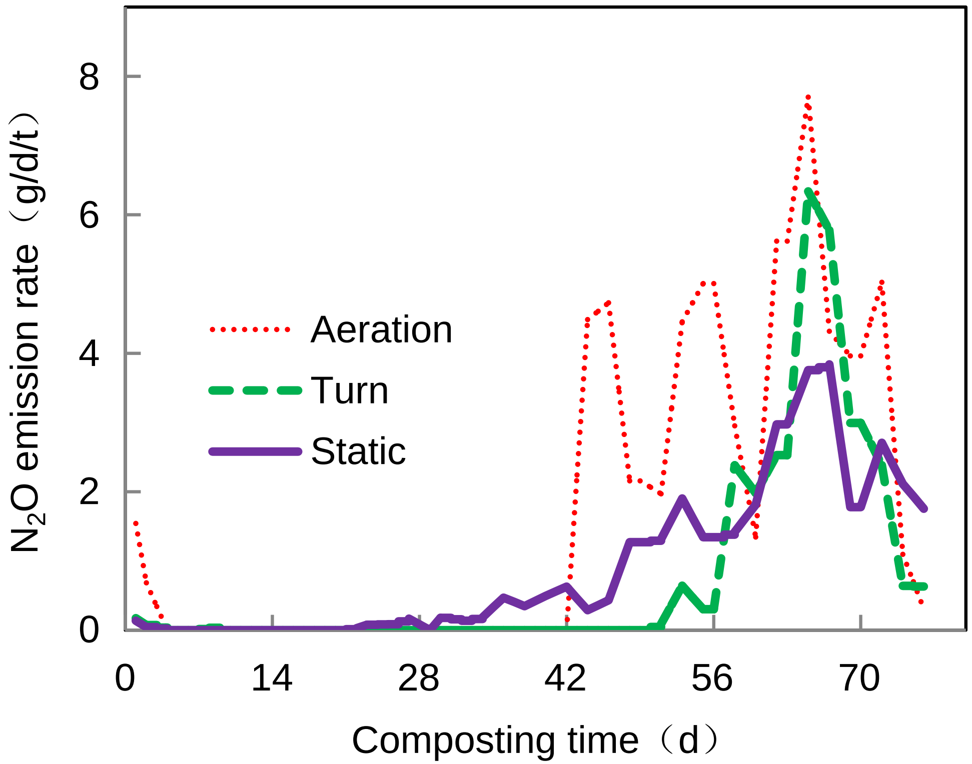
Denitrifiers

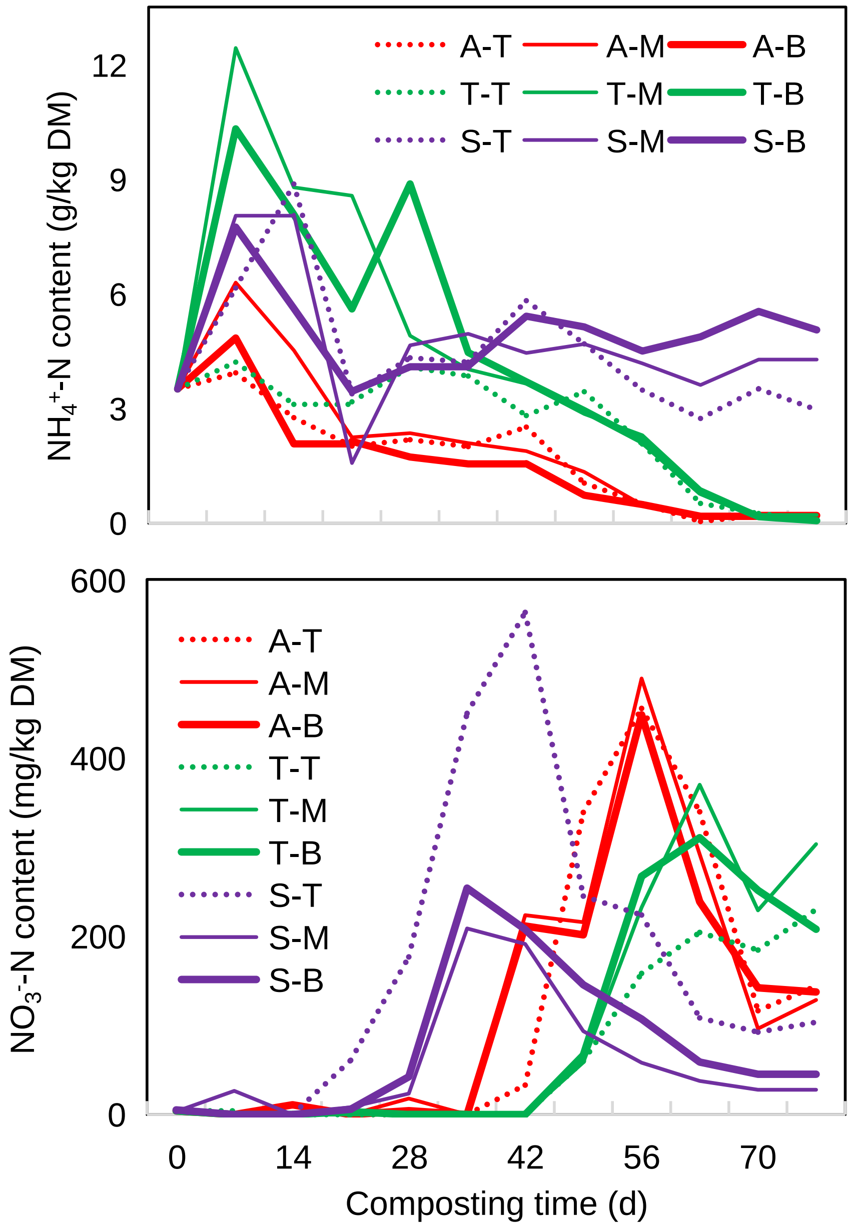
- ✓ Terminal restriction fragment length polymorphism (T-RFLP)
- ✓ Clone and sequencing

Results_T/pH/O_2/ORP



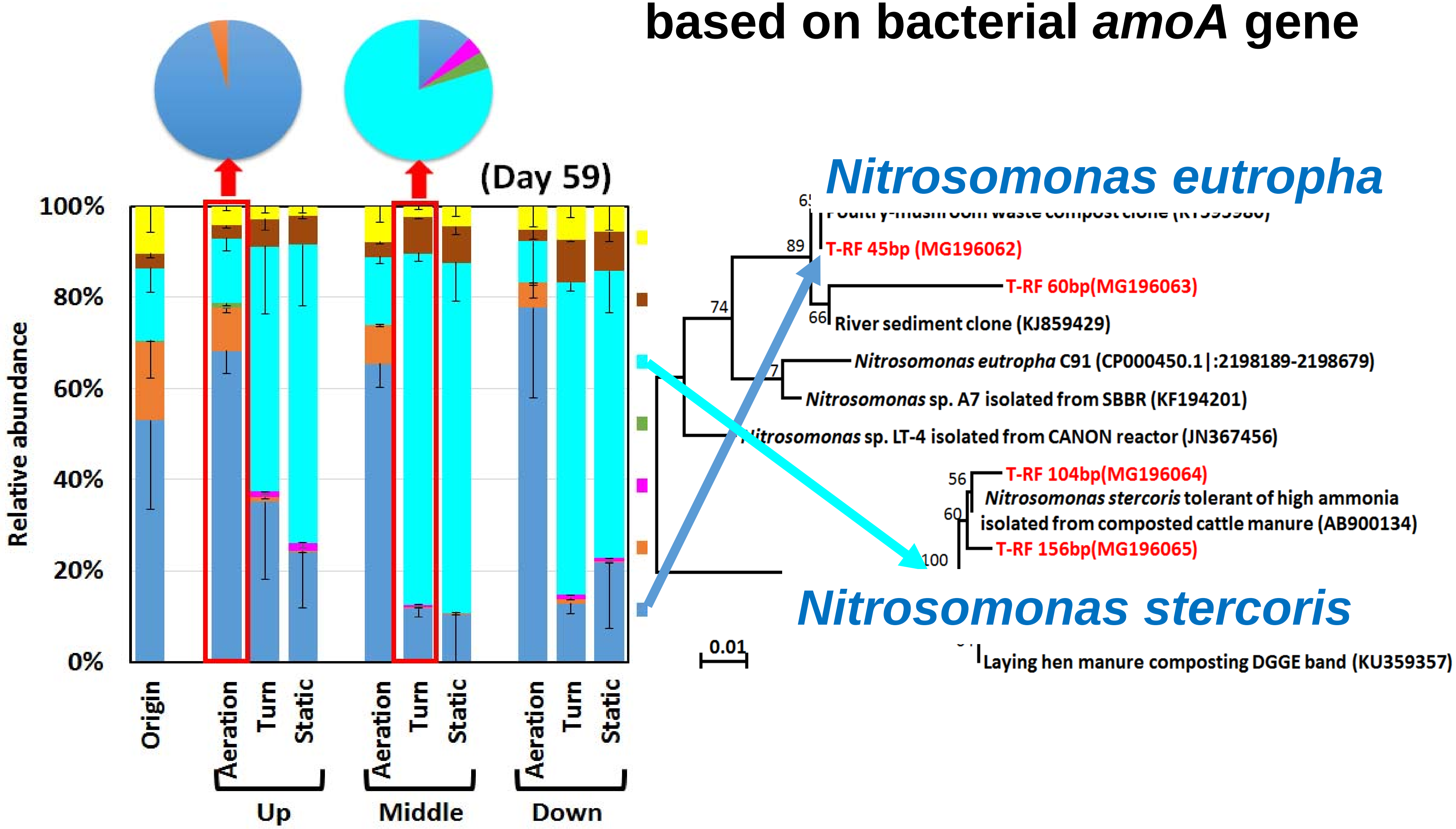
Results_$N_2O/NH_4^+/NO_3^-$





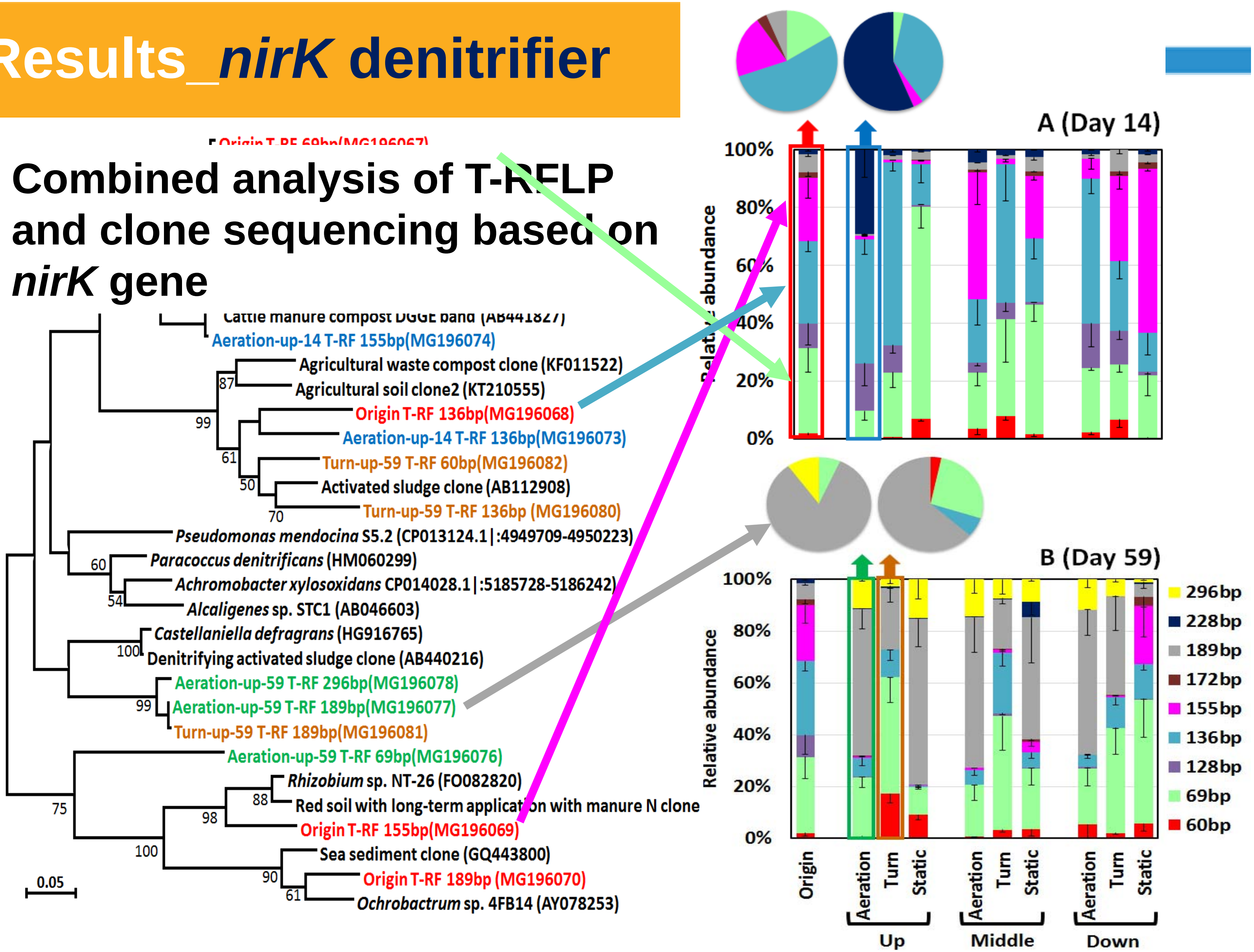
Results_ AOB

Combined analysis of T-RFLP and clone sequencing based on bacterial *amoA* gene



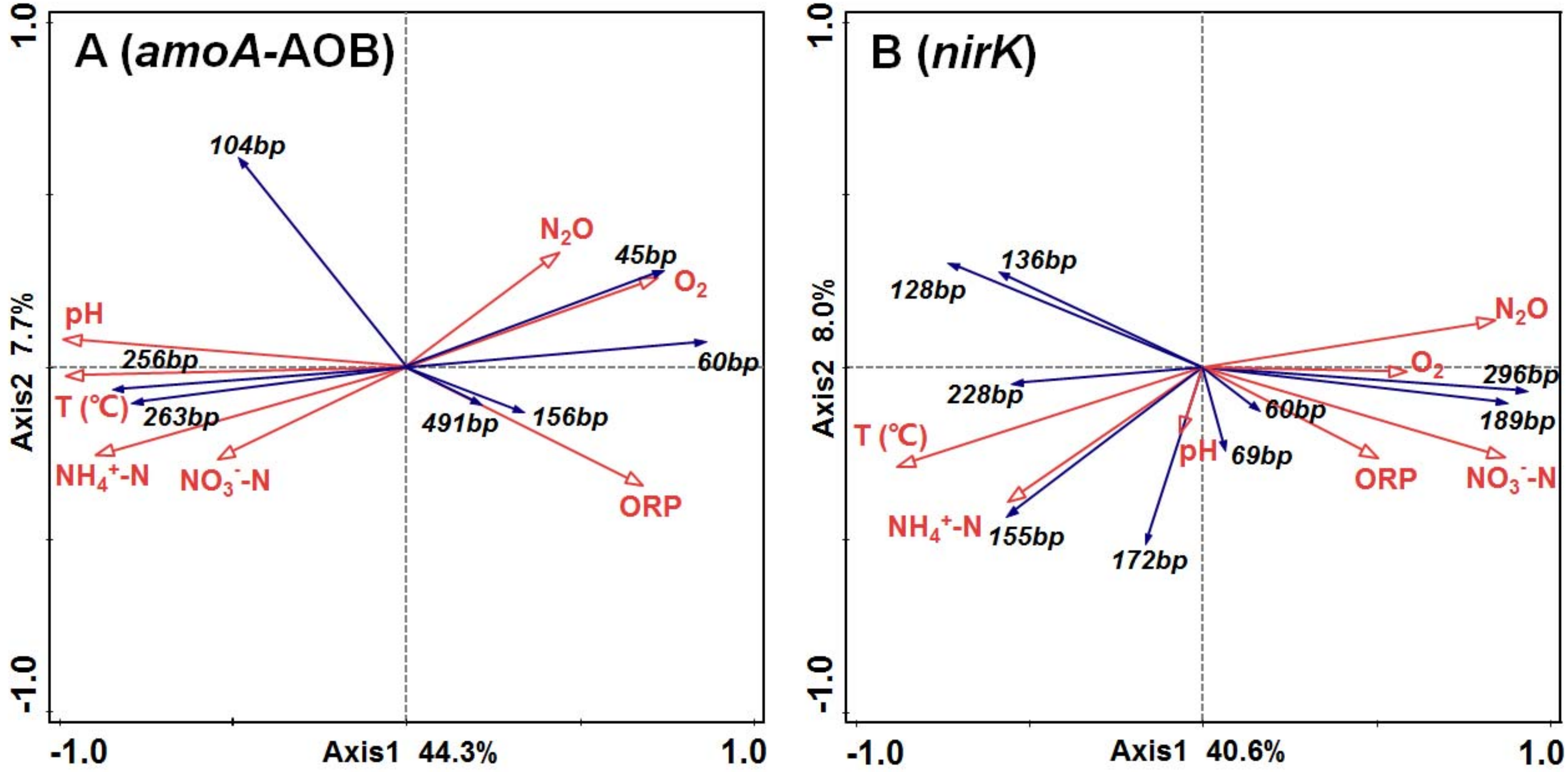
Results_*nirK* denitrifier

Combined analysis of T-RFLP and clone sequencing based on *nirK* gene



Results

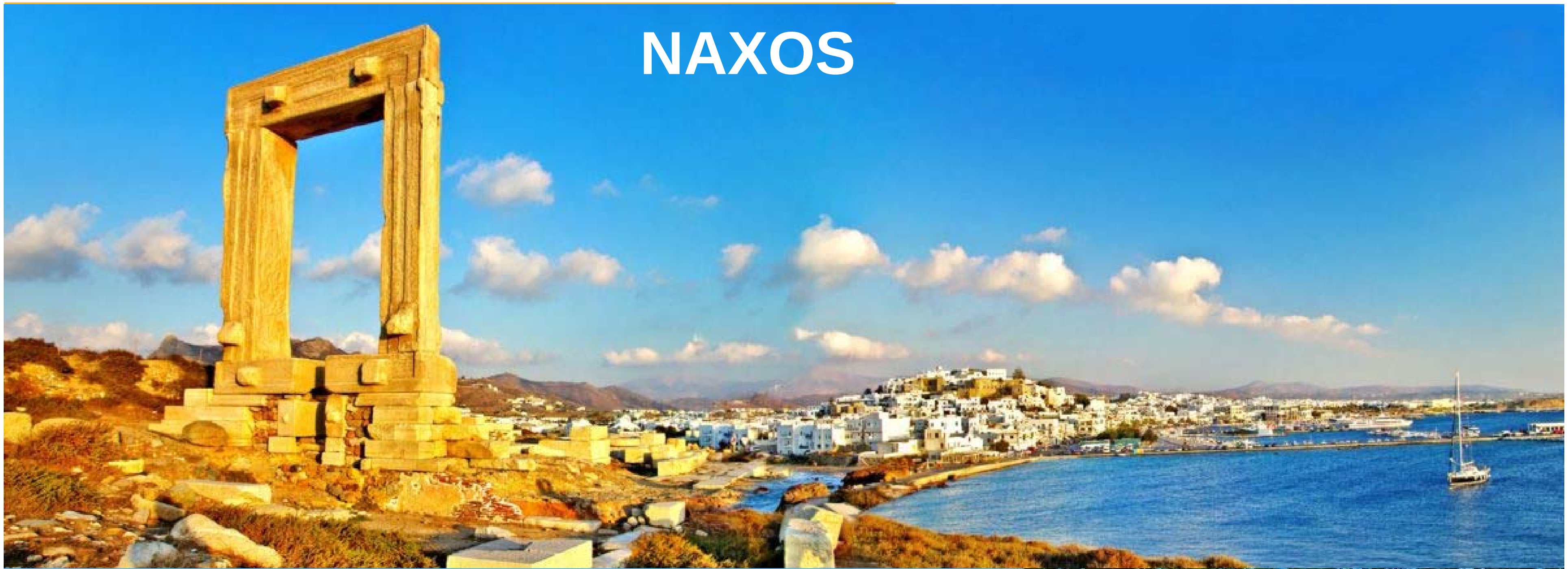
RDA pattern of functional microbial community structure and environmental factors



Conclusion

- ✓ **Variations of physicochemical factors under different composting modes influenced the community structures of AOB and *nirK*-type denitrifiers, which in turn caused the differential N2O emission patterns.**

- ✓ **Co-existence of nitrifier with 45 bp T-RF of *amoA* gene and denitrifier with 189 bp T-RF of *nirK* gene could account for the substantial emissions of N2O in forced aeration composting.**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