Concentration distribution of atmospheric particulate nitrogen and phosphorus over the North Pacific Ocean

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Introduction

Atmospheric deposition of long-range transport of nitrogen and phosphorus from continents to ocean may have profound impact on marine biogeochemistry. To probe the distribution characteristics of concentrations and compositions of nitrogen and phosphorus in marine aerosols, samples were collected during the cruise in the autumn of 2019 from the coast of China through the Yellow Sea and the East China Sea to the northwestern Pacific Ocean. We measured the concentrations of different forms of nitrogen and phosphorus species and disscussed the impact of Asian dust events on the nitrogen and phosphorus species in aerosols, which helps us to understand the formation, transformation and transmission mechanism of nitrogen and phosphorus species in the biogeochemical cycle, and also could clarify the impact of atmospheric nitrogen and phosphorus inputs on marine ecosystems.

Methodology

Sampling: 14 sets of Total Suspended Particles (TSP) samples, including 3 samples affected by dust events, were collected using KC-1000 high-volume aerosol sampler (Qingdao Laoshan Electronics Co., Ltd., China) at an airflow rate of 1.05 $m^3 \cdot min^{-1}$ during a round-trip cruise in the December 2019 from the eastern China seas (ECSs: the Yellow Sea and the East China Sea) to the northwestern Pacific Ocean (NWPO).

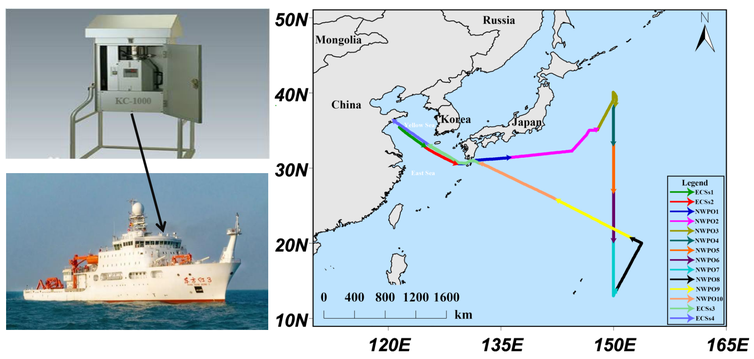

Fig.1 Cruise routes of aerosols samples collected over the ECSs and NWPO from October 31 to November 30 of 2019.

Analyzing: The analysis methods of nitrogen and phosphorus species are as following:

- DON=DTN-DIN
- DOP=DTP-DIP
- DIN=NO_3^- -N+NH_4^+-N+NO_2^--N

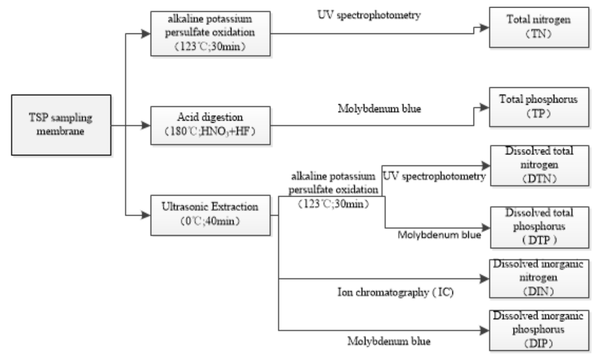

Fig.2 The determinations of different forms of nitrogen and phosphorus.species in aerosol samples.

Results and discussion

Part 1: Concentrations of nitrogen and phosphorus species in the marine aerosols during the non- dust events.

Table 1

Concentrations of nitrogen and phosphorus in the atmospheric aerosols collected over the ECSs and NWPO from October 31 to November 30 of 2019.

Sample category	DIN	DTN	TN	DIP	DTP	TP
	($\mu g \cdot m^{-3}$)			($ng \cdot m^{-3}$)		
ECSs	1.42±0.34	1.53±0.39	1.82±0.27	1.34±0.50	3.44±0.83	4.88±0.71
NWPO	0.30±0.20	0.33±0.21	0.43±0.23	0.61±0.69	1.75±1.90	3.30±2.45

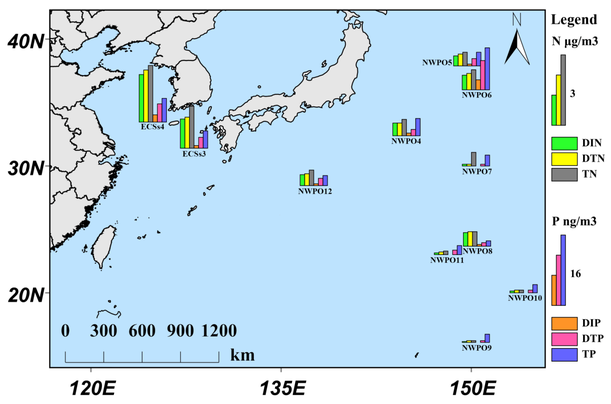

Fig. 3 The geographical distribution of non-dust aerosols concentrations of nitrogen and phosphorus species observed during the cruise in the ECSs and NWPO.

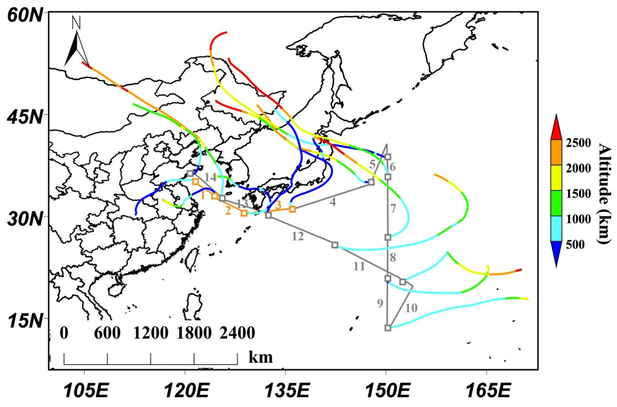

Fig. 4 The 72 h backward trajectories for samples in the ECSs and NWPO. Orange and gray rectangle indicate dust and non-dust days during the cruise, respectively. Sample number and collection range are shown.

- The concentrations of nitrogen and phosphorus species gradually decreased due to the increase of distance from shore.
- The analysis of backward trajectory shows that the source of air mass may has some effect on the concentrations of nitrogen and phosphorus in aerosols.

Part 2: Influence of dust weather on nitrogen and phosphorus

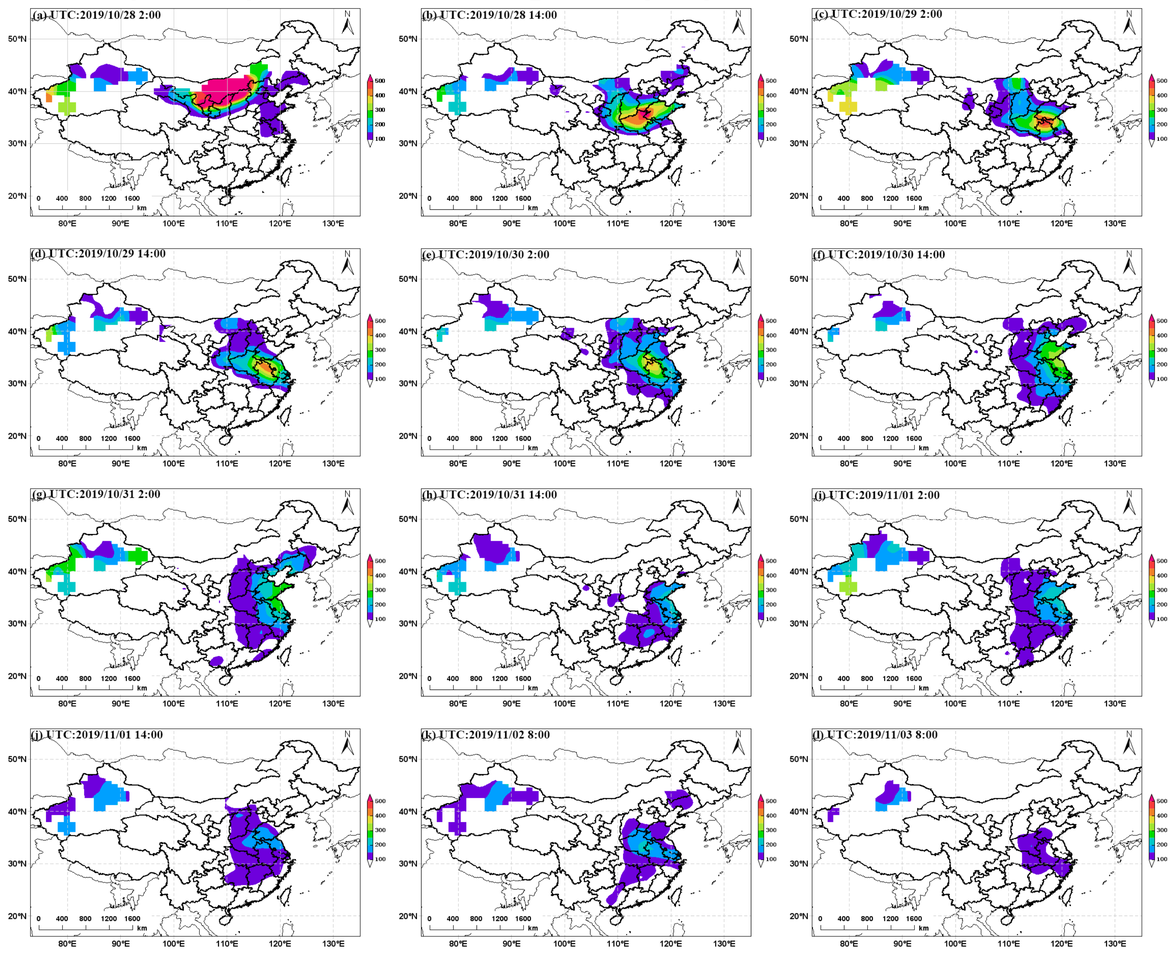

Fig. 5 The spatial distribution of PM_{10} concentration ($\mu g \cdot m^{-3}$) based on national air quality monitoring stations during the dust period

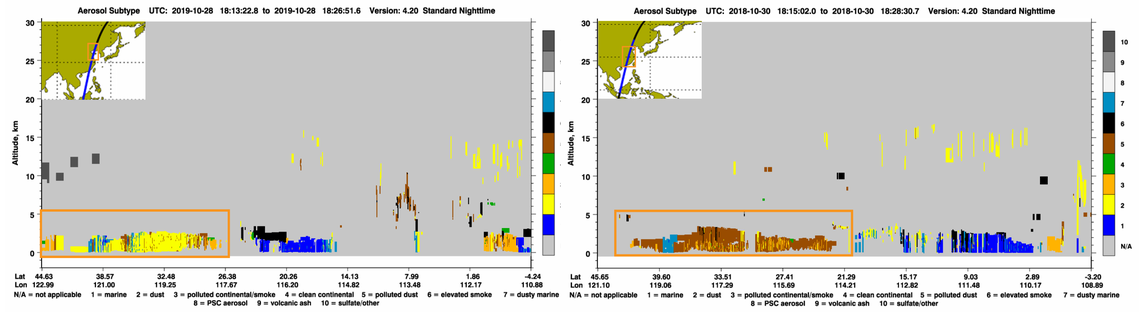

Fig. 6 Aerosol vertical distribution characteristics from CALIPSO for dust case

Table 2

Contrast of nitrogen and phosphorus concentrations in aerosol samples during dust and non-dust days .

Weather type	Sample category	DIN	DTN	TN	DIP	DTP	TP
		($\mu g \cdot m^{-3}$)			($ng \cdot m^{-3}$)		
Reference non-dust days	ECSs	1.42±0.34	1.53±0.39	1.82±0.27	1.34±0.50	3.44±0.83	4.88±0.71
	NWPO	0.48±0.00	0.49±0.00	0.61±0.00	0.68±0.00	1.59±0.00	4.17±0.00
Dust days	ECSs	11.64±3.86	11.93±3.95	16.74±5.90	23.76±6.85	40.05±10.83	166.98±66.52
	NWPO	2.38±0.00	2.43±0.00	3.34±0.00	4.87±0.00	12.26±0.00	21.16±0.00

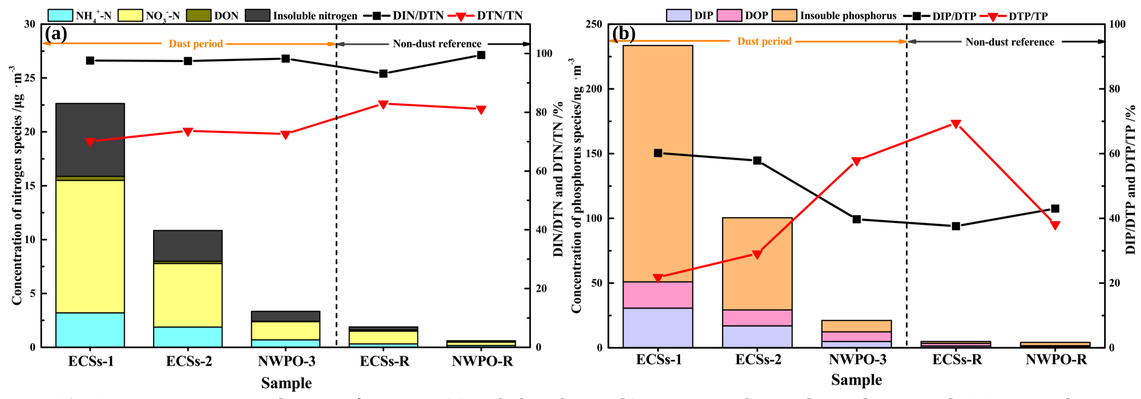

Fig. 7 Concentrations and ratios of nitrogen (a) and phosphorus (b) species in dust and non-dust period. ECSs-R and NWPO-R indicate non-dust reference samples in the eastern China seas and the northwestern Pacific Ocean, respectively.

- During the dust period, the concentrations of nitrogen and phosphorus species gradually decreased due to the increase of distance between sample location and shore, but the contribution of DTN to TN and DTP to TP gradually increased, which meant that dust aerosols could be an important nutrient source in some remote regions..

Conclusions

1. The concentrations of nitrogen and phosphorus species gradually decreased due to the increase of distance from shore.
2. The analysis of backward trajectory shows that the source of air mass may has some effect on the concentrations of nitrogen and phosphorus in the aerosols..
3. During the dust period, the concentrations of nitrogen and phosphorus species gradually decreased due to the increase of distance between sample location and shore, but the contribution of DTN to TN and DTP to TP gradually increased, which meant that dust aerosols could be an important nutrient source in some remote regions..

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