Response to Referee's Comments on acpd-2018-737: " Ambient measurement of shipping emissions in Shanghai port areas"

The many items of comments raised by the referee #1 are responded individually as following. Text is present in the format of:
Referee's comments – Black;
The Authors' responses – Blue.

Response to Referee #1

This study conducted field measurements from June to September in 2016 at Shanghai port in order to understand the impact of ship emissions on the air quality in portside. Trace gases, PM2.5 and vanadium particle number concentrations were continuously monitored at the site. Ship plumes were clearly captured by the instruments. SO2 and vanadium particle number concentrations correlated well with ship plumes. Four types of ship plumes were identified based on the mass spectra of Single Particle AMS. The contributions of ship emissions to different air pollutants in the atmosphere and in the air masses from port directions were quantified. Given that Shanghai port is the largest port in the world, this study will add values to existing literature of ship emission studies. However, the manuscript is not well organized/written and has room to be improved. In addition, there are quite a lot of grammar errors and technical mistakes, which sometimes make the reviewer confused. Furthermore, some discussions and conclusions are lack of evidence. As such, this manuscript can be considered for publication after the following specific comments are well addressed.

Specific Comments:

Abstract:

Firstly, English needs editing by a native English speaking professional or company. For example, line 16: … that shipping emissions is a major….".

Response:

The language problems, as the author responded in reply to RC2, will be corrected in the next edition of manuscript. The author acknowledge the referee's effort.

Secondly, there are also some technical mistakes. One example, lines 14-15: Gaseous (NO, NO2, SO2, O3) and particulate concentrations (PM2.5)… It should be "The concentrations of gaseous pollutants (NO…..) and fine particulate matters (PM2.5)…". Also, both shipping emission and ship emission are used throughout the manuscript which should be consistent. Another problem at lines 18-20, the subject is "Single particle mass spectra of fresh shipping emission" but the last words became "…and nitrate peaks in aged particles". This is really confusing the reviewer.

Response:

1. Original sentence revised as: "The concentrations of gaseous pollutants (NO, NO_2, SO_2, O_3) and fine particulate matters ($PM_{2.5}$), size distribution and chemical composition of ship emission particles were continuously monitored for 3 months".
2. Both of the "shipping emission" and "ship emission" are seen in literatures. This manuscript unify them to "ship emission".
3. The sentence will be "Single particle mass spectra of fresh shipping emission were identified based on the dominant peaks of Sulfate, EC and indicative metals of V, Ni, Fe and Ca".

Thirdly, the abstract should provide specific and detailed findings rather than common senses. The only specific finding described in the abstract is probably the last sentence. The others are all about common knowledge which is also applied to any other ports. What is the uniqueness of the study port?

Response:

Abstract section will be revised concentrating on the key findings and the uniqueness of present study. It will include aspects on fresh ship emission particle signatures, gaseous pollutants characters from ship emission and their contributions, size resolved ship emission particle contributions to portside and the importance of separation of land emissions.

Introduction:

As there are too many grammar errors, I have made some comments and revisions on the manuscript. I will submit my comments with the manuscript.

Response:

All the grammatical errors will be corrected in next edition.

Experimental:

It is not clear whether the sampling site is downwind location of the port or not, or whether the ship plumes could really arrive at the sampling site or not. The authors should provide more detailed description of the site. What were the prevailing winds during the sampling period and how to ensure the capture of ship plumes? There is also no information about the station. Is it a container or mobile vehicle? What is the height of the station if the outlet of the sampling tube was 3.5 m above the ground?

Response:

The referee seems to be suspicious about the possibility to detect ship emissions in port site. This question was answered by the many published studies in portside across the world (Healy et al., 2009;Ault et al., 2010;Contini et al., 2015;Merico et al., 2016).

For an online, continuous monitoring the prevailing wind notion is not useful because a prevailing wind direction does not imply wind will stay in that direction. They could shift to any directions during a long period of time. The monitoring site is certainly in the downwind direction of port when the wind is in 300°-0°-120° sector, which was clearly indicated in Fig. 1 in manuscript.

During the sampling period the prevailing wind is from southeast which is typical for summer season, as presented in Figure R1. Wind in other directions including port directions also occurred although with less frequency.

The station is on the south riverbank, as already stated in manuscript and illustrated clearly in Fig. 1 in original manuscript. The author could not understand how it is thought the station is on a container or mobile vehicle.

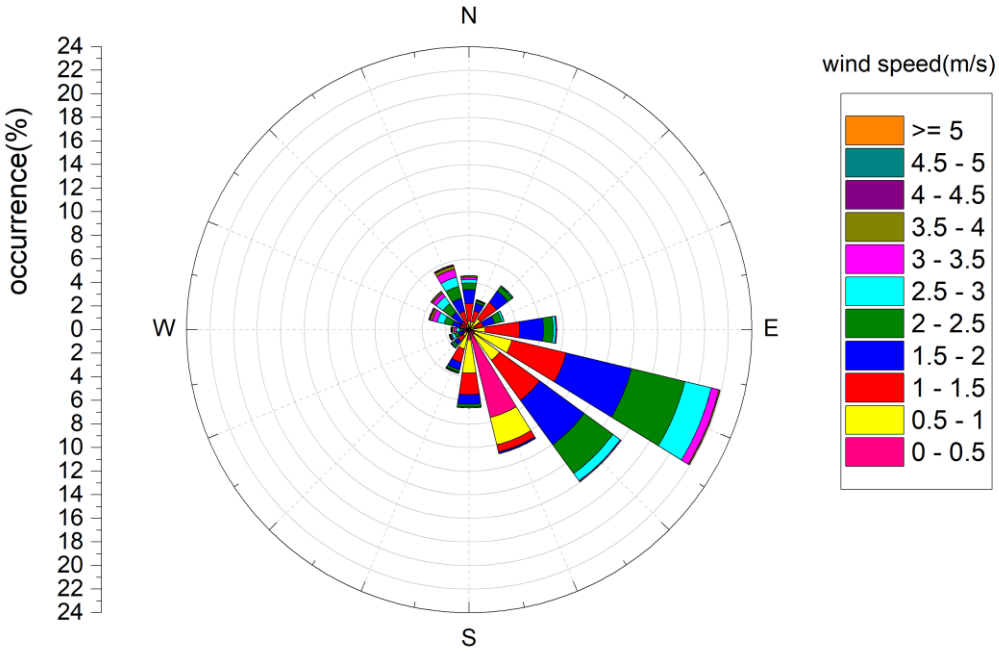

Figure R1. Portside wind rose during the study period.

Was the CO measured? Though it was claimed that calibration and maintenance of the instruments were regularly performed, brief QA/QC procedures and detection limits are still requested. Nothing was mentioned about the QA/QC of PM2.5 monitoring.

Response:

During the period the CO analyzer is not functional, so that the discussion on CO is not included in this study. The QA/QC procedures of NO-NO_2-NO_x, O_3, SO_2 and particulate $PM_{2.5}$ is under guidance of << Technical specifications for operation and quality control of ambient air quality continuous monitoring system for SO_2, NO_2, O_3 and CO >> and <<Technical specifications for operation and quality control of ambient air quality continuous monitoring system for Particulate matter (PM_{10}/$PM_{2.5}$)>> in China. QA/QC procedures in the national air quality monitoring stations are the same. Procedures and detection limits will be added. The section 2.2 will be revised as:

"The concentrations of gaseous NO-NO_2-NO_x, SO_2, and O_3 were measured continuously from Jun-21 to Sep-21, 2016. The gaseous pollutants were monitored by a suit of Thermal Scientific analyzers (NO-NO_2-NO_x, model 42i; SO_2, model 43i; O_3, 49i) installed in the monitoring station. Calibration and maintenance of instruments were regularly performed according to the requirement of relevant national standards in China. The regular practices were zero checks (through a zero air generator) and span checks (through standard NO_2 and SO_2 gas of known concentrations; the O_3 standard was generated through a calibration photometer system); The $PM_{2.5}$ concentrations were monitored by oscillating microbalance method (Thermo TEOM 1405-F). Calibration of TEOM is not relied on standard, for the aerosol mass on a filter was monitored by the oscillation frequency change of the tapered element during specified time. The regular maintenance of TEOM includes the changing of filters before the filter loading approach 100%. The flow rate of TEOM was regularly checked using a flowmeter. The lower detection limits of these

instruments are: 0.4 μg/m^3 (NO, NO_2); 0.5 μg/m^3 (SO_2); 0.5 μg/m^3 (O_3); 1 μg/m^3 ($PM_{2.5}$). Weather conditions (temperature, humidity, pressure, wind speed and direction) were monitored by a mini-weather station installed on the rooftop of the station. The monitor was about 1 m above the roof of the station and 3.5 m above the ground. Data from all the instruments and the monitor was managed in a customized database and set to 5 min resolution. Atmospheric pollutants concentrations in Shanghai city area, including gaseous pollutants and $PM_{2.5}$ concentrations, were monitored concurrently at 9 national air quality monitoring stations in 1h resolution. The averaged pollutants concentrations at these stations during the sampling period were included for comparison. ".

It is not clear how the components in particles such as vanadium were identified and quantified by the SPAMS. Detailed information is needed.

Response:

SPAMS identify particle composition, such as vanadium, in mass spectrometry method. In the ionization laser beam in SPAMS, the components in particles are ionized into ions carrying charge, then they are separated in the Time-of-Flight tube by atomic mass of the ion. Lighter ions, such as H^+, transit fastest in TOF tube and produce peaks in shortest time. The $208Pb^+$ is heavier so that it reach the MS detector with longer time. This will result a spectrum sorted by ion atomic mass. Components of different atomic mass produce peaks in different position in mass spectrum. Vanadium in particles normally produce peaks at mass = $51V^+$ and 67 (VO^+) and thus can be identified. This is the basics of MS and unnecessary to be included.

Data analysis: in the results, pollution and wind roses were presented while nothing is described about the method to draw pollution and wind roses, and how to explain the pollution and wind roses. In addition, the method of calculation of shipping contributions is improperly placed in the "Results" section, which should be described in the "Experimental".

Response:

Pollution roses are normal and frequently presented in literatures. The author has used the most normal method to draw a wind rose: firstly perform statistics (can either be minimum, maximum, counts, mean value, or any statistics) on relevant pollutant concentrations (e.g., number concentrations of vanadium particles) in every wind directions and then do the plot. If the wind speed data is also included, then another frame of information appears and a map is obtained , which will produce Fig. 7 in original manuscript.

The explanation of wind roses is equally straightforward, in that it could demonstrate, in a intuitive manner, the direction of emission sources relevant to the observation site. The author will explaine wind roses within text in appropriate places in next edition.

The method to quantify the contribution from ship emission will be moved to 'Experimental' section.

Page 5, line 3: what is ART-2a algorithm? This method was mentioned to be used to the searched clusters to generate sub-clusters of particles. However, no information at all about this method was provided.

Response:

The ART-2a is a classification algorithm conventionally adopted by SPAMS community to group similar particle based on the particle similarities. A reference on ART-2a algorithm will be added here in case that the reader want further information on the algorithm.

Results and discussions

Page 5, line 10: which typically persist for a few hours: can you tell us the specific hours in your study rather than vague value like this?

Response:

The specific value of hours is variant, most of them fall in range of 3-6 hours.

Page 5, lines 21-25: The discussion here is questionable. By looking at Figure 2, whenever ship plumes were captured, both NO and SO2/vanadium levels were high and correlated well. On what basis, the authors claimed the NOx in plumes reaching the site was aged? Using the NO/NO2 ratio in the plumes? Compared to the ratio measured in other countries and probably different type of ships? This is not convincing. Besides, NO2 is also emitted from shipping as a primary pollutant.

Response:

We have not tested NO/NO2 ratio in the exhaust because the observation was carried out in a station on land. The author also know that NO2, together with NO, is released as primary emissions. However their ratio, upon their emission into atmosphere, will subject to change quickly through the oxidation of NO into NO2 in the existence of ozone (O3), which is abundant in summer time. This was evidenced by the quickly reduced O3 level during plumes in Fig. 2 in manuscript. The referee seems to be doubtful about this reaction, which is the very basis that the NO-NO2-NOx analyzer is working on.

Page 5, line 26-29: given that shipping emission is a major source of PM2.5, it is odd that no PM2.5 peaks were found during the ship plumes in Figure 2. The reason provided by the authors is quite confused. Is it because ship emits sub-micron particles or because the malfunction of the PM2.5 monitor?

Response:

The authors have stated that $PM_{2.5}$ peaks was not as apparent as that of SO_2 and NO_x in plumes, and have not states that no $PM_{2.5}$ peaks were found. It should be made clear that only a short period of data was shown in Fig.2 only with the purpose of illustrating temporal variation in plumes. In the last question the referee is suspecting that $PM_{2.5}$ analyzer was in malfunction. The author would like to illustrate another longer period of data in Figure R2 (shown below) and let the referee make his judgement. The sharp peaks of SO_2 in Figure R2 could help to locate the plumes. If the $PM_{2.5}$ instrument is in malfunction, how did the $PM_{2.5}$ instrument happened to malfunction only in plumes? In another aspect, the SPAMS particle number concentration have shown good correlation with the $PM_{2.5}$ measurement. How did the two instruments both malfunction? It sounds ridiculous.

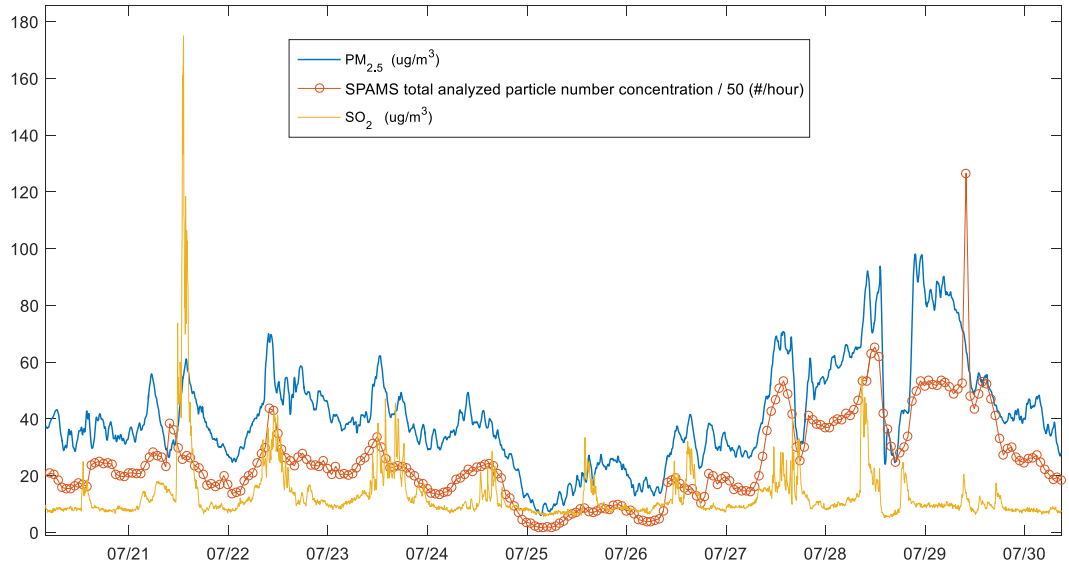

Figure R2. Temporal variations of $PM_{2.5}$, SO_2 concentrations and SPAMS analyzed particle number concentrations during Jul-20 to Jul-30 in this study.

Page 5, lines 31-32: what is the basis for the definition of ship plumes using the minimum threshold of delta SO2? In particular, the authors later claimed that in some cases the SO2 peaks were absent?

Response:

Very clear, frequent sharp peaks of SO_2 over the background SO_2 concentration is suggesting that they are emitted from adjacent combustion sources. Concurrent increases of vanadium particles suggest they are combusting Residual oil. Wind directions during plumes mainly in port directions suggest they are from ships. The cases the SO_2 peaks were absent were rare(3% cases), and will be explained in next edition of manuscript.

Page 6, lines 2-3: the reason for absent SO2 is contradictory to Figure 2. If the ships complied with the new regulations, why would you still see SO2 peaks in ship plumes? This kind of discussion is misleading.

Response:

As stated above, the cases the SO_2 peaks were absent were rare and will not affect significantly the result of the study. The new regulation only confine the Sulfur content in fuel, not eliminate the Sulfur from the fuel.

Page 6, line 16: “This result suggests that shipping activities are the main source of SO2 plumes in port”. Please comment on the NOx emission from ships - is it not important, because of impacts of land-based traffics? But later in Page 10, lines 15-18, you claimed NO was higher than SO2 in fresh ship plumes.

Response:

The author think that NOx emission from the land-based traffic to the site is important considering all surrounding sources. The claim in Page 10, lines 15-18 was under the condition that land-based emission were excluded by considering the period when site was only under influence of port direction.

Page 6, line 18: it does not make sense to compare a site near sources with sites in a city without any detailed characteristics of the locations. It would be more meaningful to compare the ship

emissions in this study with other similar studies conducted in Shanghai. In fact, there are a number of ship emission studies in this city.

Response:

The comment is not acceptable. We made comparison between air pollution level in a port site with that at the urban area of the same city, How did it make non sense? The referee had better suggest a study which he think make more sense.

Page 6, lines 21-24: the explanation of low PM2.5 levels at the port site is not convincing at all. Why would other pollutants from shipping emissions be higher if this was caused by clean air?

Response:

The slight lower $PM_{2.5}$ concentration at the port site is a fact. The author only postulated possible explanations.

Page 6, line 27: the title reads awkward. Should it be "Particles in the background air and the ship plumes"?

Response:

The title is revised as: " Discrimination of fresh and background ship emission particles in port site".

Page 6, lines 28-31: These should be in "Experimental" section.

Response:

Will be revised.

Pages 6-7: the first paragraph of section 3.2.1 is messy and lack of logic. It should be re-organized.

Response:

Not acceptable. The referee think it is messy and lack of logic if he is not familiar.

Page 7, line 13: The wind rose distribution….. in figure 3. This should be merged with the description of mass spectra for Figure 3 earlier. When it is first mentioned, you should describe all once.

Response: Is it a really publicly accepted rule in scientific paper?

The text will be considered for some reorganization.

Page 7, lines 16-17: "Background vanadium particles, … in all directions". This is not true in Fig 3(d).

Response:

Original text has stated "prominent" and "nearly".

Page 7, lines 20-21: There is no actual comparison at all. No idea about the particle size in background air, larger or smaller?

Response:

Revised as: " The size distributions of fresh vanadium particles were dominated by fine particles (< 0.5 um in diameter), as shown in Fig. 4. ".

Page 7, line 22-23: "significant fine ship emission particles were still detected in fine size range". The terms have been randomly used everywhere. What do you mean fine ship emission particles? very non-professional description. It should be fine particles from ship emissions.

Response:

Will be uniformed to 'fine particles'.

Is this contradictory to your previous claim that PM2.5 in ship plumes is lower than that in urban air? In other word, the PM2.5 in background air could be more significant and be detected more significantly?

Response:

It should be noted that particles are measured by SPAMS in number concentrations, while $PM_{2.5}$ is

measuring particle mass. The fine particles are only a fraction of $PM_{2.5}$ and not always correlated with $PM_{2.5}$. No contradictory identified.

Page 7, lines 24-27: These two sentences are repeated. the 2nd sentence contains grammar errors.

Response:

Revised as: "The non-spherical, fractal shape of fresh vanadium particles is consistent with the typical shapes from fresh combustion sources (Ault et al., 2010). ".

Page7, lines 28-30: these two sentences are not related. Lack of logic.

Response:

Revised as: "It was normally found that ship emission particles were enriched in ultrafine size range(<100 nm) as measured by other techniques, resulted an elevated particle number concentrations (PNC) more considerable than mass concentrations (Donateo et al., 2014;Jonsson et al., 2011;Merico et al., 2016). ".

Page 7, line 30: "size distribution of fresh particles…". how do you define "fresh particles from ship exhaust" and "particles from ship emissions"?

Response:

Uniformed to "ship emission articles".

Page 7, line 31:" …that the number concentration mainly concentrated in UF mode (<100 nm)". very poor English writing. It is non-professional at all.

Response:

Revised as: " The fine particle modes could be as small as 30 nm in fresh ship emission plume (Gonzalez et al., 2011;Moldanova et al., 2013).".

Page 7, lines 32-33: No idea at all why PM2.5, NOx and SO2 were suddenly discussed here. This section is about SPAMS measurement data. Also, where showed that PM2.5 had less increase than NOx and SO2? Moreover, are you sure EF of PM are typically much lower than NOx and SO2 in all types of ships with different fuel?

Response:

The less apparent peaks of $PM_{2.5}$ during plume period has been noted in section 3.1.

The sentence revised as: " With the size distribution of ship emission particles, the less apparent peaks of $PM_{2.5}$ mass than NO_x and SO_2 during plume periods, as shown in section 3.1, is related with the small size of ship emission particles. In another aspect, the reported PM emission factors of ships are typically smaller than NO_x and SO_2 (Agrawal et al., 2010;Moldanova et al., 2013), which would also contribute.";

Line 34: Do not understand if there is any connection with less significant increase in PM2.5 mass concentration.

Response:

Seen revisions proposed in last comment.

Page 8, lines 1-3: Terrible explanation. The authors lack basic knowledge.

Response:

The referee did not point out the what is the basic knowledge and how they are terrible. In discussion of aerosol mass and number concentrations, it is easy to understand that particle number multiplied the average mass of individual particles produce the total mass concentration. Consider the supposed two cases: An aerosol sample of low numbers of particles but with larger size, and an aerosol sample of larger particle numbers but small average size. The two case may generate the same mass concentration. However, the difference between the two cases is that

the latter produce larger surface area which favors the secondary accumulation (secondary formation of nitrate, sulphate, organics) to particle surface. This is why the number concentration matters. Hope the explanation is less terrible to the referee.

The text will be revised as “Since the size and mass of fresh exhaust particles are small, the mass concentration PM from exhaust pipes would be inappropriate to represent their real mass contribution after atmospheric aging. This study suggests, as other authors did, that particle number concentration (PNC) be adopted to fully characterize primary ship emitted particles.”.

Page 8, line 9: “The negative mass spectra” how? To me it should be negative m/z value for HSO4-. Mass spectra should not be negative. Please make it clearer. In addition, the whole sentence is confusing. “…other negative EC peaks…”. Specifically what are they in the spectra?

Response:

The positive and negative mass spectra a common nomenclature in SPAMS literatures, and will not generate confusions. The EC peaks is already noted in 3.2.1 section when it appear the first time.

Page 8, line 20: Firstly, this description is unclear. How could "chemical composition" suggest distinct physical properties"? Secondly, is Fig 6 about this? But it is clear that Fig 6 is about temporal pattern of particle number concentration.

Response:

The sentence is revised as “The four ship emission particle type detected in this study displayed distinct distributions (Fig. 6).”.

Page 8, lines 26-27: Did you scan it using TEM? If not, how do you know yours is the same as other studies?

Response:

The several sentences will be revised as: “In previous study an organic particle type was identified by TEM images of ship emission particles (Moldanova et al., 2013). This organic particle contain vanadium impurities, which agree with organic and vanadium signatures in mass spectra in Figure 5. During the incomplete combustion (e.g., starting up phase) the organic vapours in fuels will condense onto particles (ash, EC particles) in the cooler ambient environment, resulting uniform size distribution compared with other types (lower right panel in Figure 6). The V-OC type are more transient in that the peak width of its concentration peaks are normally narrower than other types (~1 hours contrasting to 3~5 hours of other types).”;

Page 8, lines 27-29: Again, you do not have evidence to say this - is the reason that the size distribution of V-OC is different from other types related to incomplete combustion?

Response:

This is an inference to explain the observed result. No existing study is found by author.

Page 8, line 31: “…. suggesting they are principally emitted in specific phases of engine operations.” Any references support this?

Response:

This item was omitted, as shown in previous comment.

Page 8, line 33: “UF size…” I guess it means ultra-fine. If correct, what is the size range of ultra-fine particles?

Response:

It’s size include < 400 nm (aerodynamic diameter) in this study. Next edition they will be uniformed

to “fine size range”.

Page 9, line 1: “….product of combustion of RFO (Moldanova et al., 2013).” But your measurement was conducted after the implementation of sulfur reduction regulations. This means the fuel used at berth is not RFO but clean fuel.

Response:

Clean fuel with S <0.5% will also produce Soot particles.

Line 2: are mainly detected in larger size range (> 0.5 um) (Fig. 6). The peak particle size for V-EC, V-ECFe and V-Ash looks similar in Fig. 6. How would you say this?

Response:

The size distribution shape of V-EC, V-ECFe and V-Ash types in upper-right panel is presented in absolute numbers. In smaller size range (< 0.5 μm) their number concentration all declined due to the decreased detection efficiencies of SPAMS in this size range. However, their relative contributions change as a function of size as shown in bottom-right panel.

Lines 3-5: This fits other types of particles as well. I don't understand why you said this here. This is basic knowledge.

Response:

The referee likes to speak “basic knowledge”. Is it really your basic knowledge if I have not present it?

Lines 5-6: “The origin of V-ECFe types are probably the result of internal mixing between V-EC and V-Ash particles”. Any possible reasons for this speculation?

Response:

This statement and the latter one has been removed.

Line 7: how do you know or do you believe it?

Response:

See previous statement.

Lines 9-18: The whole paragraph is nothing to do with your results but information about other studies. This should be in "Introduction" section.

Response:

Will be moved to “introduction”.

Lines 19-20: Very confused statement and unclear purpose.

Response:

Revised as: “ Due to the close proximity to urban region of Shanghai, the present coastal site is under stronger influences from land emissions, contrasted with the marine port far from coastal area (Zhao et al., 2013).”.

Lines 22-23: “… clearly showed that they are under the overwhelming influences of land emissions on the sampling site.” Why? How do we read the pollution roses in Fig 7? How do we know they were affected by other sources?

Response:

The information in wind roses in figure 7 is rather clear that the port site PM2.5, NOx are strongly influenced by land-based emissions, while the SO2, and ship emitted vanadium particles are under the major impact of ship emissions in port. The ozone wind rose indicates apparent depletions where NOx and SO2 are concentrated.

Lines 26-27: “Because the air pollution in this two conditions are so different,……” Which two conditions?

Response:

It is referring to periods when the site is influenced by land-based and port emissions.

Page 9, lines 30-32 and page 10, lines 1-2: all these should be in “Experimental” section.

Response:

Will be moved to “Experimental” section.

Page 10, lines 8-12: Quite confused discussion. Re-written.

Response:

Revised as “From the calculation method, it could be inferred that the wind frequencies at each directions will influence the calculated results. Therefore, The estimation of impacts from ship emission will produce biased estimation on the prevailing wind directions (that is, the sea direction). During the summer time when southeast winds are prevalent. Adjacent coastal regions other than port area may experience more ship emissions so that their contribution will be larger.”

Page 10, lines 15-17: Here you finally evidenced the major contribution of ship emissions to NOx. But if you went to section 3.1, you claimed that NOx were mainly from land traffics while ship contribution is not important. The two explanations are contradictory.

Response:

The referee have not understood the point. The mentioned situation is after the land-based emission have been ruled out. It is nothing surprising to found that, if the emission in Shanghai is removed, the activities in port region will certainly be the dominant source of both NO_x and SO_2.

Page 10, lines 19-20: Do you compare the absolute concentrations of these pollutants attributed to ship emissions in these two studies? This kind of comparison using percentage is very dangerous! I bet the total concentrations of these pollutants in these two studies are totally different.

Response:

The absolute contributions will be presented and discussed in next edition, together with suggestions raised by referee #2.

Lines 24-25: Did you do t-test to say this? ~4% vs. 5.9% is similar to me. Importantly, compare absolute concentrations. The comparison based on percentage does not make sense and can mislead readers.

Response:

No t-test. The absolute concentrations will be present.

Conclusions

The conclusion section is poorly written. It must be re-organized and re-written.

Response:

Conclusion will be revised.

Ault, A. P., Gaston, C. J., Wang, Y., Dominguez, G., Thiemens, M. H., and Prather, K. A.: Characterization of the Single Particle Mixing State of Individual Ship Plume Events Measured at the Port of Los Angeles, Environmental Science & Technology, 44, 1954-1961, 10.1021/es902985h, 2010.

Contini, D., Gambaro, A., Donateo, A., Cescon, P., Cesari, D., Merico, E., Belosi, F., and Citron, M.: Inter-annual trend of the primary contribution of ship emissions to PM2.5 concentrations in Venice (Italy): Efficiency of emissions mitigation strategies, Atmospheric Environment, 102, 183-190, 10.1016/j.atmosenv.2014.11.065, 2015.

Healy, R. M., O'Connor, I. P., Hellebust, S., Allanic, A., Sodeau, J. R., and Wenger, J. C.:

Characterisation of single particles from in-port ship emissions, Atmospheric Environment, 43, 6408-6414, 10.1016/j.atmosenv.2009.07.039, 2009.
Merico, E., Donateo, A., Gambaro, A., Cesari, D., Gregoris, E., Barbaro, E., Dinoi, A., Giovanelli, G., Masieri, S., and Contini, D.: Influence of in-port ships emissions to gaseous atmospheric pollutants and to particulate matter of different sizes in a Mediterranean harbour in Italy, Atmospheric Environment, 139, 1-10, 10.1016/j.atmosenv.2016.05.024, 2016.
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Zhao, M., Zhang, Y., Ma, W., Fu, Q., Yang, X., Li, C., Zhou, B., Yu, Q., and Chen, L.: Characteristics and ship traffic source identification of air pollutants in China's largest port, Atmospheric Environment, 64, 277-286, 10.1016/j.atmosenv.2012.10.007, 2013.