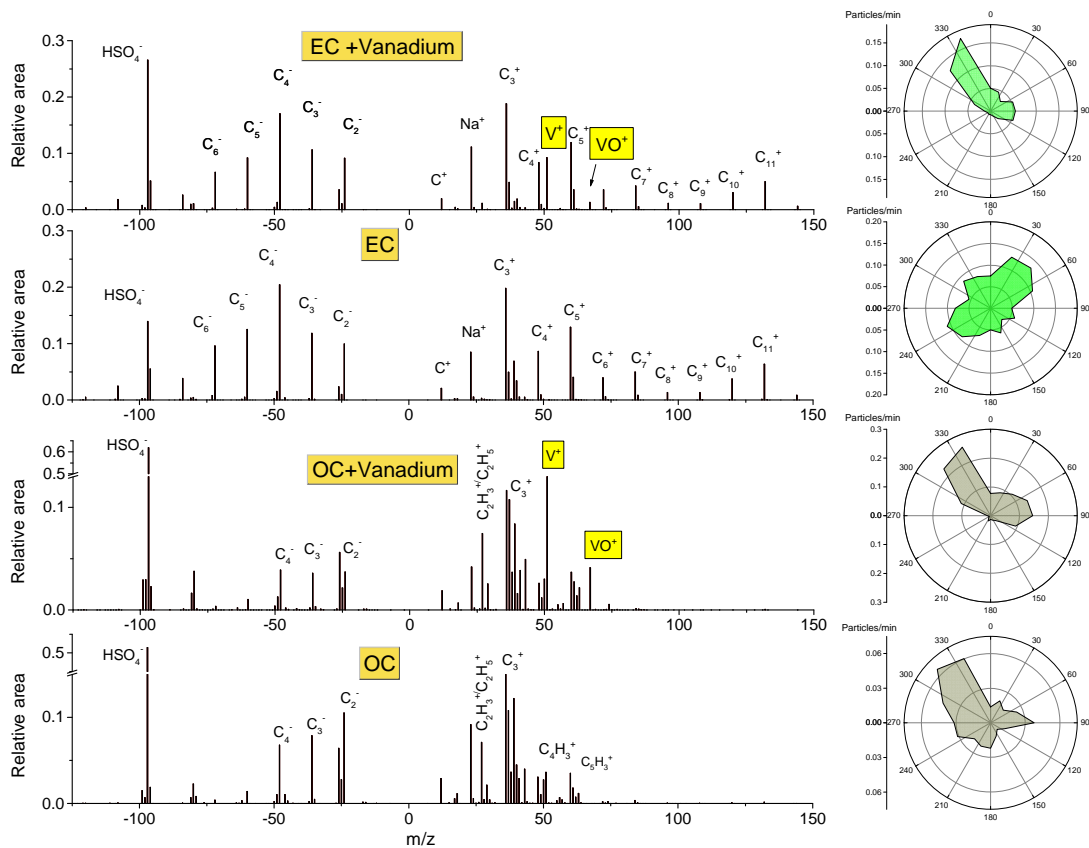


1 **Supplementary Material**

2 The identification method relying on Vanadium signatures left a problem that this method lose some
3 portion of shipping emission particles which produce no or insignificant Vanadium peaks (Xiao et al.,
4 2018) . However, within the analyzing capability of SPAMS, Vanadium signatures are still the most
5 reliable indicator of shipping emission particles in a real ambient condition. The present site in port
6 area is both influenced by emission sources from the shipping activities and traffics on land. Single
7 particle signature from diesel vehicles has displayed some similarity with shipping emission (especially
8 for low Sulfur fuel oil, MGO, IFO) because of the resemblance in chemical composition between them
9 (Toner et al., 2008;Xiao et al., 2018). In this situation, to identify 'true' shipping emission particles
10 from total particles will became difficult or even impossible if we discard the reliable clue of Vanadium.
11 In this supplementary material we illustrate the wind roses of several particle clusters of similar
12 composition with the only major difference of Vanadium (Figure S1). From the figure it is clear that
13 single particles with Vanadium is an ideal indication of shipping emission source from port directions,
14 while the exclusion of Vanadium will only result an unwanted inclusion of particles from land sources.
15 Therefore, in present study the online single particle measurement was utilized to indicate the
16 occurrence of shipping emission plumes, not to dig out every shipping emission particles.

17



18

19 **Figure S1: Mass spectra and wind roses of representative particle clusters with and without**
 20 **Vanadium peaks.**

21

22 **References**

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