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Effects of continental emissions on cloud condensation nuclei (CCN) activity in the northern South China Sea during summertime 2018

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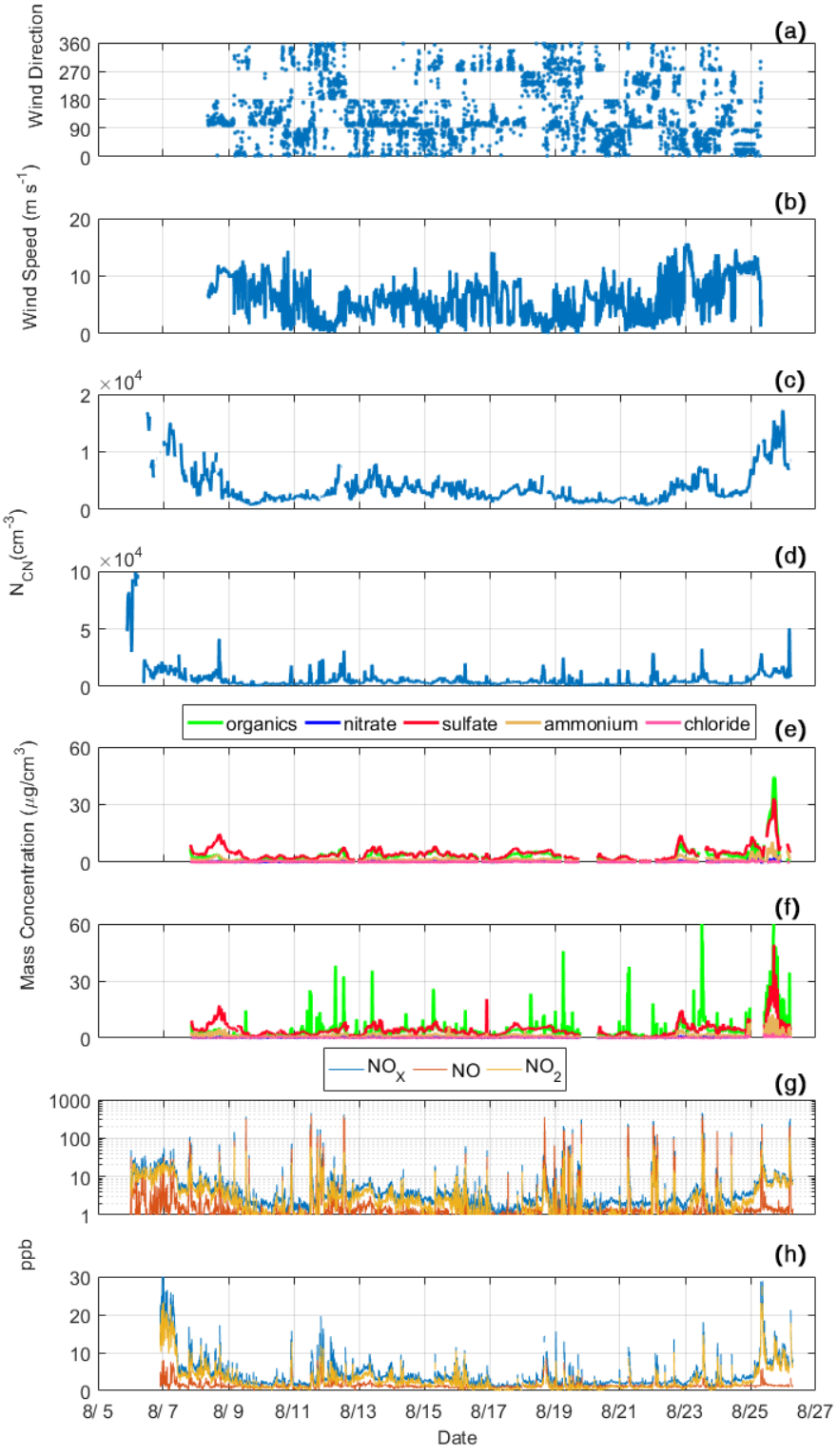

Figure S1. Temporal profile of wind direction (a) and wind speed (b), N_{CN} after (c) and before (d) removal of the abnormal data, chemical composition after (e) and before (f), and $NO/NO_2/NO_X$ before (g) and after (h) removal of the abnormal data.

We use the following protocol to remove spikes:

There are mainly three potential sources for the spikes: 1) emissions from our ship and other adjacent ships; 2) emissions from the kitchen in our ship; 3) smoking from sailors in our ship. We measure $NO/NO_2/NO_X$ every minute in comparison to 5 and 15 min per cycle respectively for the CCN and TOF-ACSM measurements. Hence more spikes could be found in the profiles of $NO/NO_2/NO_X$ than in organic composition from the TOF-ACSM measurements. We found that the spikes do not correspond significantly to changes of the wind direction and speed as shown in Fig. S1. The spikes could last from minutes to hours. If they are from smoking, then they could last a few minutes. In some cases, if other ships sailed adjacently (i.e., within a few hundred meters) in the same direction, emissions from those ships could cause spikes that would last a few hours. When the ship anchored, emissions from the ship itself could cause spikes as well. In this study, the protocol for removal of spikes is to keep as many data as we can while avoiding too complicated data processing. We argue that ship emission could be one of the major particle sources in the South China Sea region. Here ship emission should be regional representative, rather than emissions from the ship itself and emissions from other adjacent ships which are really close to the measurement ship (i.e., within several hundred meters) because those emissions could cause extreme heterogeneity of spatial distributions. Hence those emissions should be excluded from further data analysis. Base on the above rationales, we remove all the spikes associated with smoking, emissions from the ship and from other adjacent ships, and emissions from the kitchen on the ship.

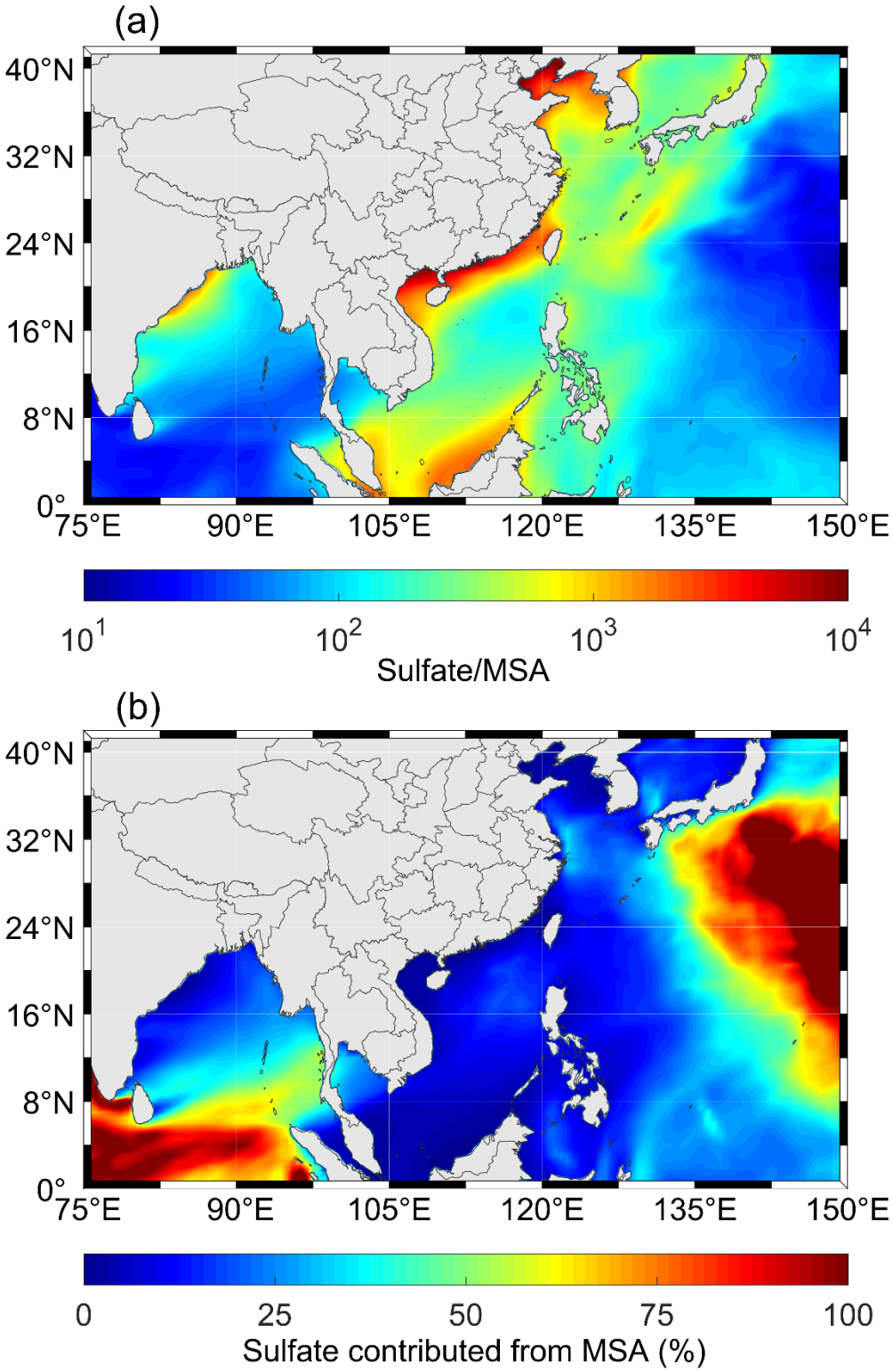

Figure S2. Ratio of sulfate/MSA (a) and sulfate fraction contributed from MSA (b) at 925 hPa from MERRA-2 reanalysis dataset (GMAO, 2015). The contribution of MSA to sulfate in this study is calculated based on a ratio of 18 for NSS sulfate to MSA reported in remote marine region (Savoie et al., 2002).

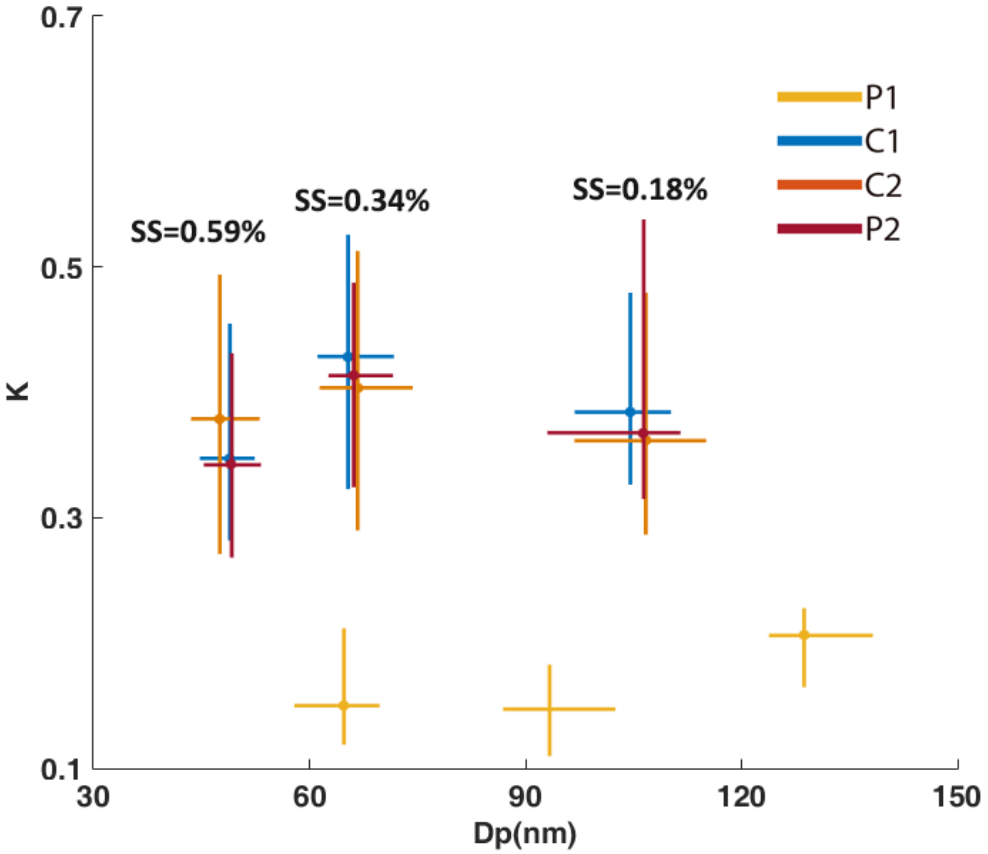

Figure S3. The median and interquartile κ value at 0.18%, 0.34% and 0.59% ss during the P1, C1, C2 and P2 periods. Different colors represent different periods.

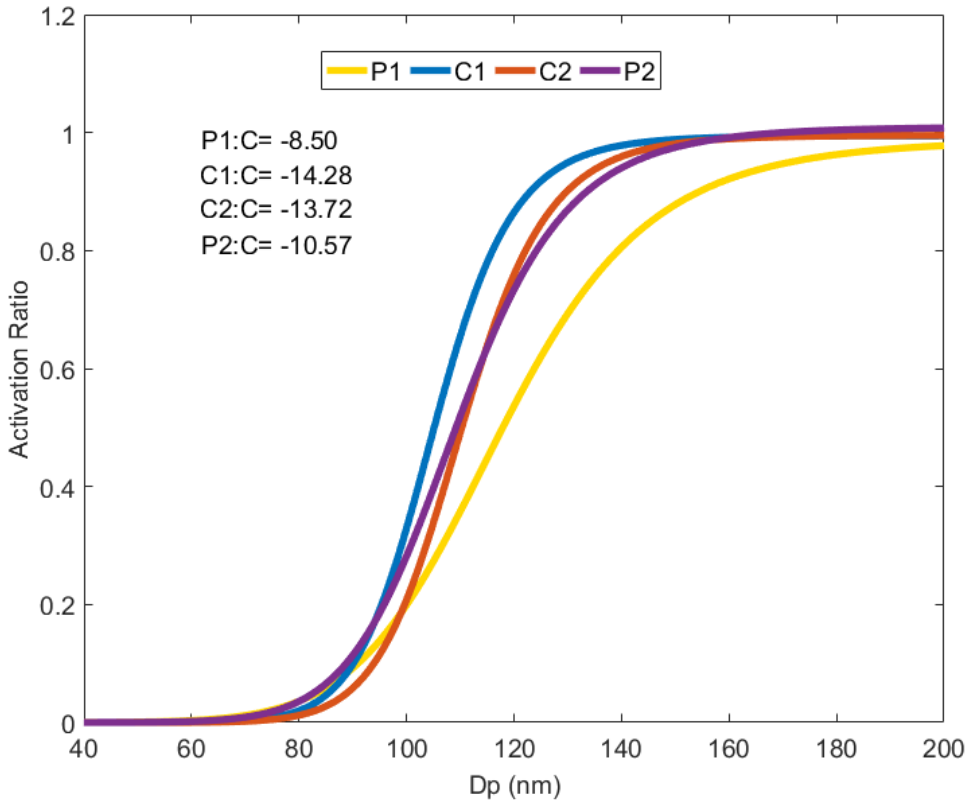

Figure S4. The activation curve at 0.18% ss during the P1, C1, C2 and P2 periods. Different colors represent different periods.

References

Global Modeling and Assimilation Office (GMAO) (2015), MERRA-2 inst3_3d_aer_Nv: 3d,3-Hourly,Instantaneous,Model-Level,Assimilation,Aerosol Mixing Ratio V5.12.4, Greenbelt, MD, USA, Goddard Earth Sciences Data and Information Services Center (GES DISC), Accessed: 8, 2018, 10.5067/LTVB4GPCOTK2.