Supplementary Materials for

# Large contribution of organics to condensational growth and formation of cloud condensation nuclei (CCN) in remote marine boundary layer

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## S1. Classification of air mass origins

The origins of the air masses arriving at the ENA site are classified based on the air mass back-trajectories. Here 10-day back-trajectories are simulated using the HYSPLIT 4 model (Stein et al., 2015) every hour starting from 500 m above the ground level, with the input of NCEP Global Data Assimilation System (GDAS) meteorological data. The back-trajectories are then classified into four categories using the following approach. First, all air masses that had passed over the North America (130° ~ 60° W, 35° ~ 62° N) or northern Europe (-10° W ~ 30° E, 35° ~ 62° N) are classified as “Continental origins”. Second, air masses that passed over the Arctic regions (latitude higher than 62° N) are then denoted as “the Arctic”. Third, among the remaining air masses, those passed over subtropical oceans (latitude lower than 35° N) at times 6 - 150 h prior are classified as “Subtropical origins”. Last, all other air masses are considered as “mid-latitude Atlantic”. The dominant air mass origin during a given growth event is designated as the air mass category of that event.

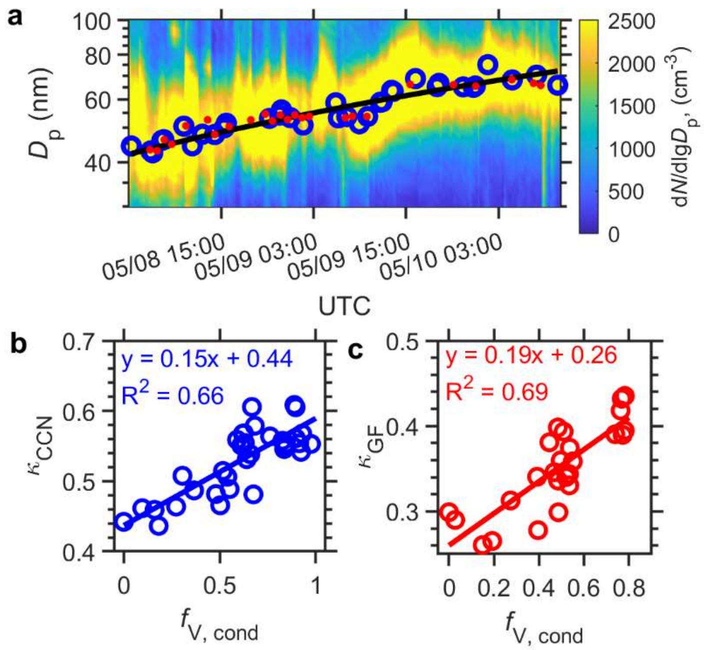
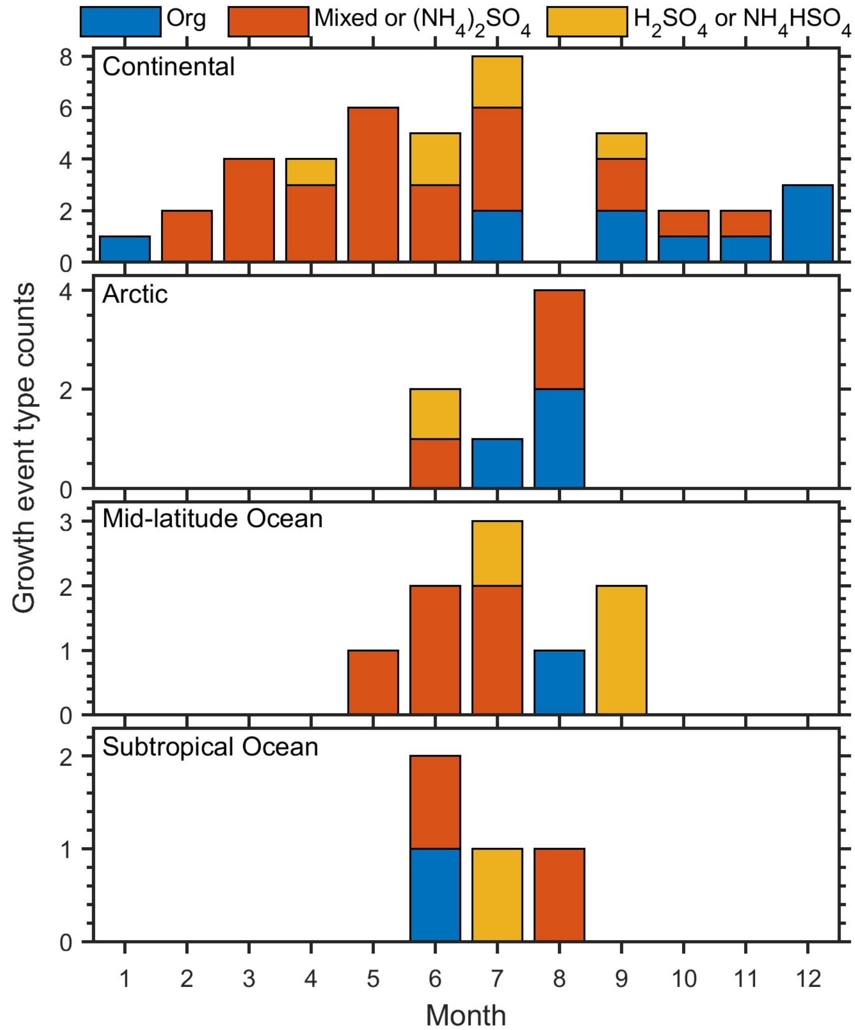



**Figure S1. An example case of deriving $\kappa_{c,CCN}$ and $\kappa_{c,GF}$ for the same growth event.** (a) Aerosol size distribution during the growth event. The blue circles and red dots represent lognormal-fitted Aitken mode diameters at the times of the SCCN and HTDMA measurements, respectively. The black line shows the growth of the Aitken mode diameter during the event. (b) A $\kappa_{c,CCN}$ value of 0.59 (i.e., the sum of slope and intercept) is derived from the linear fitting of $\kappa_{CCN}$ vs. $f_{V,\,cond}$. This value falls in the intermediate-$\kappa_{c,CCN}$ category and suggests that the major condensing species included both organics and sulfates or dominated by $(NH_4)_2SO_4$. (c) A $\kappa_{c,GF}$ value of 0.45 is derived from the variation of $\kappa_{GF}$ following the same approach.




35 **Figure S2. Monthly distribution of condensational growth event and the dominant condensing species for each type of air mass origins.**

**Table S1: Hygroscopicity parameter $\kappa$ of potential condensing species over remote oceans**

| Compound | $\kappa_{GF}$ | $\kappa_{CCN}$ | Reference |
|---|---|---|---|
| $H_2SO_4$ | 1.19 | 0.90 | (Petters and Kreidenweis, 2007) |
| $NH_4HSO_4$ | 1.0 | 0.9 | (Schmale et al., 2018) |
| $(NH_4)_3H(SO_4)_2$ | 0.51 | 0.65 | (Petters and Kreidenweis, 2007) |
| $(NH_4)_2SO_4$ | 0.53 | 0.61 | (Petters and Kreidenweis, 2007) |
| $CH_3SO_3H$ (MSA) | 0.36 | <0.44 | (Johnson et al., 2004; Tang et al., 2019) |
| α−pinene/$O_3$/dark SOA | 0.022~0.037 | 0.1 | (Petters and Kreidenweis, 2007) |
| β−pinene/$O_3$/dark SOA | 0.009~0.022 | 0.1 | (Petters and Kreidenweis, 2007) |
| SOA particles generated via OH radical oxidation | 0~0.3 (20% to 50% lower than corresponding $\kappa_{CCN}$) | 0~0.3 (Generally below the line of: (0.29 ± 0.05)*O:C | (Chang et al., 2010; Massoli et al., 2010) |

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