Supplementary Material

Development of an automated system (PPWD/PILS) for studying $PM_{2.5}$ water-soluble ions and precursor gases: field measurements in two cities, Taiwan

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1. Diurnal variations during "wind effect" periods

The "wind effect" period refer to the time when the wind blows from a relatively fixed direction involving more natural environments than other directions. From July 16 to 22 in Zhongshan site, winds came from southeast (wind direction between 90 and 120 °) except a short random time on July 19, with wind speed from 1 to nearly 6 m s^{-1}. From October 4 to 12 in Zhudong, winds came from northeast (wind direction around 50 °) with wind speed from 1 to 8 m s^{-1}. We singled out these two periods to see the diurnal information under the influence of the winds for precursor gases as shown in Fig. S1, and for $PM_{2.5}$ major ions in Fig. S2.

As can be seen from Figs S1 and S2, in both sites precursor gases, HONO and SO_2, and all $PM_{2.5}$ major ions exhibit lower concentrations and irregular diurnal variations as compared to those averaged over the entire measurement periods. These would be related to the cleaner winds natural areas (e.g. northeastern mountains in Zhudong) as well as the irregularly varied wind speeds. The concentration of NH_3 in either site was observed higher over the "wind-effect" period than over the entire period, which could be largely associated with the ammonia-rich natural air in less neutralization of other species with low concentrations to form secondary particles. In Zhongshan site, the trend of NH_3 was well correlated with that of NH_4^+ particularly at evening rush hours, indicating the additional urban activities round Taipei City. As a whole, during the special period in each site, the wind effect dominated an atmosphere with less formation of secondary inorganic

aerosols.

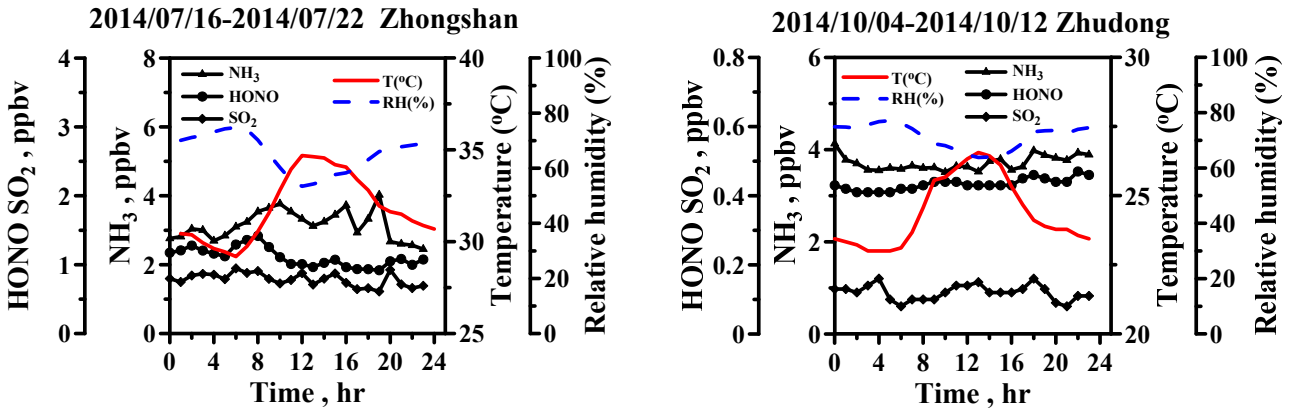

Figure S1. Diurnal variations during the periods when wind effects predominated, for precursor gases (NH_3, HONO and SO_2), T and RH at (a) Zhongshan site from July 16 to 22, and (b) Zhudong site from October 4 to 12.

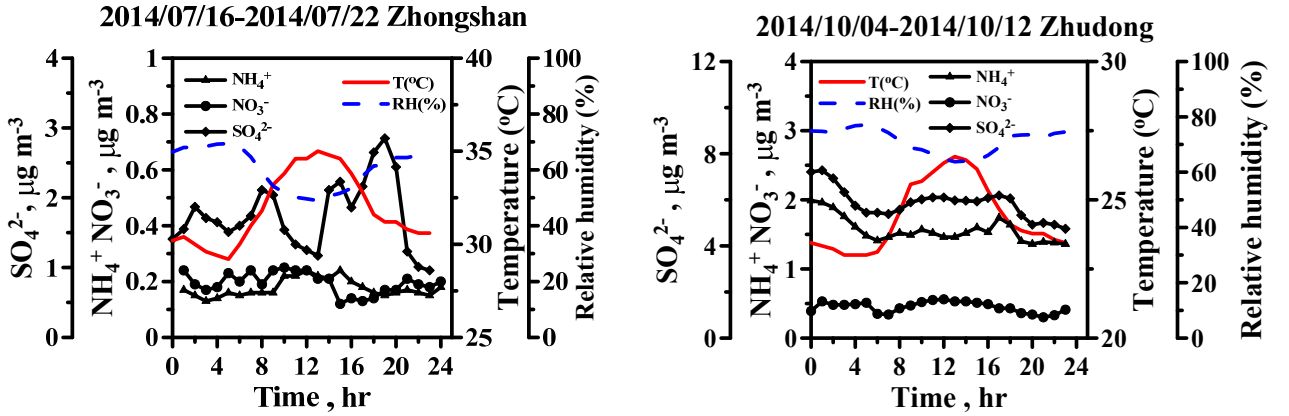

Figure S2. Diurnal variations during the periods when wind effects predominated, for $PM_{2.5}$ major ions (NH_4^+, NO_3^- and SO_4^{2-}), T and RH at (a) Zhongshan site from July 16 to 22, and (b) Zhudong site from October 4 to 12.

2. Ion balances during "wind effect" periods

The plots of the total cations versus total anions and $[NH_4^+]$ versus $2[SO_4^{2-}] + [NO_3^-]$ in aerosols during the periods when winds predominated for both measurements are presented in Figs. S3 (a)

and (b), respectively. It can be seen that the data during this special periods dominated the deviations from 1:1 line for each site in both plots, based on the fact that data for entire measurements show very similar fitting parameters. These indicate departures from ion equilibrium due to the unstable meteorological condition during the "wind effect" periods. In addition, for Zhudong with more natural regions, the deficit in NH_4^+ might be associated with some unmeasured ammonium cations in soil-derived species (Shon et al., 2012) related to the mountain areas.

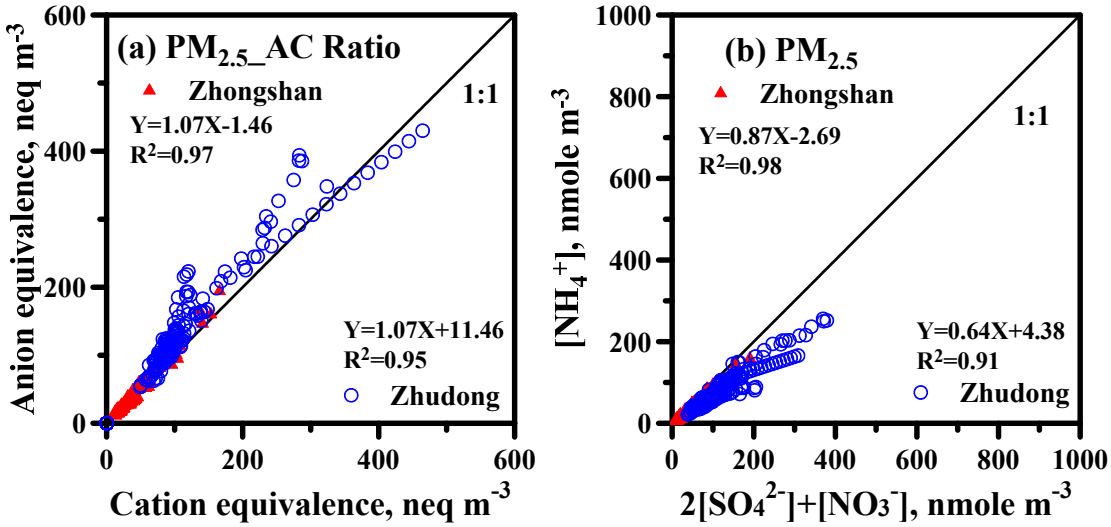

Figure S3. Ion balance data during the periods when wind effects predominated for both sites: (a) Plot of Σ cations vs. Σ anions; (b) Plot of $2[SO_4^{2-}] + [NO_3^-]$ vs. $[NH_4^+]$.

References

Shon, Z. H., Ghosh, S., Kim, K. H., Song, S. K., Jung, K., and Kim, N. J. (2013). Analysis of water-soluble ions and their precursor gases over diurnal cycle. *Atmos. Res.* 132: 309-321.