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Comment on egusphere-2022-375

Anonymous Referee #2

Referee comment on "Vertical profiles of cloud condensation nuclei number concentration and its empirical estimate from aerosol optical properties over the North China Plain" by Rui Zhang et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-375-RC2, 2022

The manuscript on "Vertical profiles of cloud condensation nuclei number concentration and its empirical estimate from aerosol optical properties over the North China Plain" by R. Zhang and co-authors made airborne measurements of vertical profiles of CCN concentrations and scattering coefficients over the southern plain of Hebei province. Using this data, they have investigated the influence of thermal structure (TIL) and airmass origin on vertical profiles of CCN. The CCN concentration is estimated using the scattering coefficient and its spectral variation.

Considering the limitations and uncertainties associated with the retrieval of vertical profiles of aerosols and CCN using different techniques, the direct measurements of these parameters onboard the aircraft are very important. But I feel disappointed with the way the authors described their experimental details. Details of the sampling inlet are not provided. (i) What is the effect of aircraft propeller on aerosol sampling? (ii) Whether sampling flow was iso-kinetic? (iii) What was the sampling efficiency of the inlet used? (iv) What was the cruising speed of the Y-12 Turboprop? (v) How do authors account for ram heating? (vi) How do authors account for the flow instabilities during ascending and descending phases of spiral flights? (vii) How much is the total sampling time available for each vertical level? (viii) Whether CCN measurements at all the supersaturations were carried out at each altitude? If not, how do authors decouple the change in CCN due to supersaturation change and also due to vertical variation?

The authors mentioned that CCN profiles have a strong dependence on the number and thickness of TIL. This is mostly due to the TIL influence on the vertical transport of aerosols. On the other hand, the influence of airmass trajectory indicates long-range transport. In other words, when long-range transport dominates at higher altitudes, the influence of vertical transport of aerosols from the lower atmosphere is irrelevant. If long-range transport is the prominent mechanism, then how could authors associate TIL with CCN concentration?

How do authors link CCN spectra with activation efficiency? In lines 313-314, the authors mentioned that "A lower value means a stronger aerosol activation ability (i.e., more coarse-mode particles or stronger aerosol hygroscopicity), and vice versa." This is not always true when hygroscopicity changes with the size of the particles.

How much time CCN counter required for attaining set supersaturation, especially when supersaturation changes from 1.28% to 0.44%? What is the sanctity of 0.7% supersaturation? Why lower supersaturations (<0.4%) are excluded from the sampling? What is the broad range of atmospheric supersaturation observed over the study region?

What kind of drier was used to remove the humidity of the air sampled by the nephelometer? Whether this could maintain a constant RH throughout the campaign?

Line 173: Replace "this" with "integrating"

There are data gaps in Figure 5. For example (i) panel a RF2_c: no CCN data is shown for ss<0.8%. Similar is the case with panel b RF6_b and panel C RF7_c. Explain?

What is the reason for high CCN activation at higher altitudes than lower levels? Normally, fine mode aerosols are transported to higher altitudes and these particles have lower CCN efficiency than coarse mode aerosols.

How does long-range transport increase SAE? Generally, ageing and chemical processing during the long-range transport increases the size of the particles and reduces SAE. Moreover, ultrafine secondary particles have less residence time and they may not get transported to longer distances to increase SAE.

Better association between CCN at high SS and scattering coefficients are expected because both CCN and scattering coefficients depend on the entire size distribution of the aerosol system. On the other hand, predicting CCN concentration for lower ss is challenging, since a small portion of the aerosol NSD (coarse mode) gets activated. Using the high-resolution data (1 sec), the authors should show the CCN vs scattering coefficients for low and high supersaturations.

Figure 7: Standard deviation of the β and γ should be included.

The β and γ showed better association with SAE during the southeast airmass period than the northwest airmass. But the CCN estimated using b and g did not show good

association for south-east airmass. Please explain this discrepancy.