Supplement of

Vertical profiles of cloud condensation nuclei number concentration and its empirical estimate from aerosol optical properties over the North China Plain

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Table S1. The fitting results of Eq. (1) for the 11 level flights

<table>
<thead>
<tr>
<th>Flight code</th>
<th>Altitude (km)</th>
<th>C</th>
<th>k</th>
<th>R^2</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF1_a</td>
<td>3.6</td>
<td>156</td>
<td>0.18</td>
<td>0.59</td>
</tr>
<tr>
<td>RF2_a</td>
<td>0.4</td>
<td>3029</td>
<td>1.71</td>
<td>0.94</td>
</tr>
<tr>
<td>RF2_b</td>
<td>3.6</td>
<td>2317</td>
<td>0.86</td>
<td>0.88</td>
</tr>
<tr>
<td>RF2_c</td>
<td>0.4</td>
<td>6560</td>
<td>1.75</td>
<td>0.92</td>
</tr>
<tr>
<td>RF6_a</td>
<td>2.5</td>
<td>282</td>
<td>0.46</td>
<td>0.91</td>
</tr>
<tr>
<td>RF6_b</td>
<td>1.1</td>
<td>9981</td>
<td>0.79</td>
<td>0.83</td>
</tr>
<tr>
<td>RF7_a</td>
<td>3.1</td>
<td>391</td>
<td>0.62</td>
<td>0.95</td>
</tr>
<tr>
<td>RF7_b</td>
<td>0.4</td>
<td>3218</td>
<td>0.65</td>
<td>0.73</td>
</tr>
<tr>
<td>RF7_c</td>
<td>1.8</td>
<td>828</td>
<td>0.37</td>
<td>0.91</td>
</tr>
<tr>
<td>RF8_a</td>
<td>0.6</td>
<td>8120</td>
<td>0.89</td>
<td>0.91</td>
</tr>
<tr>
<td>RF11_a</td>
<td>0.7</td>
<td>10310</td>
<td>0.97</td>
<td>0.96</td>
</tr>
</tbody>
</table>

**Sampling method**

The sampling device is above the front of the airplane cabin, which is not affected by the propeller after the plane takes off. The sampling flow was iso-kinetic. As described in Wang et al. (2018), the conical double diffuser aerosol inlet, designed for a Twin Otter, is installed on the Y-12. This inlet system is manufactured by Droplet Measurements Technologies (MP-1806-A and MP-1807-A, Boulder, CO, USA) (Hegg et al., 2005). The passing efficiency is expected to be near 100% for particle diameters up to 2.5 μm and near 50% for particles between 3 and 4 μm (Huebert et al., 2004; McNaughton et al., 2007). The typical cruising speed of aircraft is 60-70 m s^{-1}, with ascent/descent rates of 2–5 m s^{-1}. Ascents and descents are gentle to avoid turbulence taking about 20 min to ascend 3000 m or ~150 m/min. The ram heating is considered by adjusting the measured air temperature and relative humidity:

\[
\text{Temp}_\text{adj} = \frac{(\text{Temp} + 273.15)}{1 + 0.2 \times \text{Rf} \times \text{M}^2} - 273.15,
\]

where,

- \text{Temp}_\text{adj} – adjusted air temperature by taking the ram heating effect into account
- \text{Temp} – measured air temperature (°C)
- \text{Rf} – recovery factor (Rf = 0.896445604404384)
- \text{M} – mach number, which is calculated from the measured true air speed and calculated speed of sound:
  \[
  \text{M} = \frac{\text{Airspeed}_\text{True}}{\text{Speed}_\text{sound}}
  \]
  \[
  \text{Speed}_\text{sound} = 331.3 \times \sqrt{\frac{(\text{Temp} + 273.15)}{273.15}}
  \]

Relative humidity is also adjusted by multiplying the ratio of saturated water pressures under measured and adjusted air temperature:

\[
\text{RH}_\text{adj} = \text{RH} \times \frac{\text{svpt}}{\text{svpat}};
\]

where,

- \text{svpt} = 6.1121 \times \exp \left(18.678 - \frac{\text{Temp}}{234.5}\right) \times \left(\frac{\text{Temp}}{257.14 + \text{Temp}}\right);
- \text{svpat} = 6.1121 \times \exp \left(18.678 - \frac{\text{Temp}_\text{adj}}{234.5}\right) \times \left(\frac{\text{Temp}_\text{adj}}{257.14 + \text{Temp}_\text{adj}}\right)
Figure S1. Seventy-two-hour HYSPLIT back trajectories in southeasterly air masses at 0.5, 1.5, 2.5, and 3.5 km starting altitudes (showing RF6_1 as the example).

Figure S2. Same as Fig. 3 but for RF2_2 $N_{CCN}$ profile with no TIL.
Figure S3. Same as Fig. 3 but for RF6_2, RF7_1, RF7_2, RF8_1, and RF11_1 $N_{CCN}$ profiles with one TIL.
Figure S4. Same as Fig. 3 but for RF1_2 $N_{CCN}$ profiles with dual TIL.
Figure S5. Same as Fig. 6b but in (a) RF1_2, (b) RF6_1, (c) RF6_2, (d) RF7_1, (e) RF7_2, and (f) RF8_1 vertical spiral flight.
**Figure S6.** The two fitting parameters $\beta$ and $\gamma$ as a function of the aerosol scattering Ångström exponent (SAE) in northwesterly air masses (a and c) and southeasterly air masses (b and d). The dots are mean values averaged in 0.3-wide SAE bins. The black lines are best-fit lines from linear regression. Linear relations and correlation coefficients are given in each panel. The yellow error bars denote standard deviations.

**Reference:**