Interactive comment on “CCN predictions using simplified assumptions of organic aerosol composition and mixing state: a synthesis from six different locations” by B. Ervens et al.

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We thank U. Pöschl for his suggestion to extend our paper by a comprehensive discussion of previous CCN studies. In the attached additional table (Table 3 in the revised manuscript), we have summarized the results of prior CCN studies at different locations, together with the assumptions that have been made about the hygroscopicity of organics and their mixing state. This table will be described in an additional Section 5, entitled ‘Comparison to previous CCN studies’. In agreement with our study, the table shows that other investigators have also pointed out the presence of an externally mixed, hydrophobic (CCN inactive) organic mode around the critical activation diame-
ter of CCN (∼ 50-200 nm) (Broekhuizen et al., 2005; Cubison et al., 2008; Quinn et al., 2008; Lance et al., 2009). We also refer to studies that did not include a CCN closure study but reported size resolved measurements with the same findings (Kuwata and Kondo, 2008; Shinozuka et al., 2009). Other previous studies show that with increasing distance from sources an assumed internal mixture of insoluble organics leads to reasonable CCN closure results (i.e., within a factor of 2). At very remote locations, where air masses did not have any influence of major pollution sources for several days, aerosol is sufficiently aged that organics appear to be hygroscopic. The range of kappa(org) that has been assumed in such studies is 0.1 – 0.5. In summary, this additional overview of previous CCN studies corroborates our findings of the transition of externally mixed insoluble organics over internally mixed insoluble organics to internally mixed soluble organics. It also gives more confidence in our suggested values for kappa(org) and organic mixing states in different scenarios.


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<table>
<thead>
<tr>
<th>Location</th>
<th>Dist [km]</th>
<th>κ</th>
<th>Mixing state</th>
<th>‘slope’ S [%]</th>
<th>Comment</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverside close</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>int</td>
<td>2.8-7.1</td>
<td>0.1-0.9; hydrophobic org at ~100 nm, size-resolved composition</td>
<td>(Cubison et al., 2008)</td>
</tr>
<tr>
<td>Houston (ship) close</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>ext</td>
<td>0.79-4.1</td>
<td>0.1-0.9; hydrophobic org at ~100 nm, size-resolved composition</td>
<td>(Quinn et al., 2008)</td>
</tr>
<tr>
<td>Houston (aircraft) close</td>
<td></td>
<td>κ&lt;sub&gt;all&lt;/sub&gt; = 0.6</td>
<td>int</td>
<td>1.03</td>
<td>Hydrophobic org at ~100 nm, size-resolved composition</td>
<td>(Lance et al., 2009)</td>
</tr>
<tr>
<td>New Hampshire</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>ext</td>
<td>1.16</td>
<td>0.56-0.6; assumption: 10% of org fraction soluble</td>
<td>(Broekhuizen et al., 2005)</td>
</tr>
<tr>
<td>Vancouver 45</td>
<td>0.001 &lt; κ&lt;sub&gt;org&lt;/sub&gt; &lt; 0.11</td>
<td>int</td>
<td>-0.8-1</td>
<td>0.19-0.5</td>
<td>size-resolved composition</td>
<td>(Shantz et al., 2008)</td>
</tr>
<tr>
<td>Guanzhou (China)</td>
<td>60</td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0.32 ± 0.1</td>
<td>int</td>
<td>1.0 ± 0.07</td>
<td>0.27; κ derived based on HTDMA</td>
<td>(Rose et al., 2008)</td>
</tr>
<tr>
<td>Toronto (rural)</td>
<td>70</td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>int</td>
<td>0.89-1.14</td>
<td>0.42; above clouds</td>
<td>(Chang et al., 2009)</td>
</tr>
<tr>
<td>Duke Forest (polluted)</td>
<td>10s</td>
<td>κ&lt;sub&gt;all&lt;/sub&gt; = 0.13</td>
<td>int</td>
<td>1.7 - 2.1</td>
<td>0.2; boundary layer and free troposphere</td>
<td>(Stroud et al., 2007)</td>
</tr>
<tr>
<td>Monterey</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>int</td>
<td>0.94-0.95</td>
<td>0.2; above clouds</td>
<td>(Wang et al., 2008)</td>
</tr>
<tr>
<td>California Coast</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>int</td>
<td>1.1-1.15</td>
<td>0.2; above clouds</td>
<td>(Furutani et al., 2008)</td>
</tr>
<tr>
<td>Jeju Island 100s</td>
<td>100s</td>
<td>κ&lt;sub&gt;all&lt;/sub&gt; = 0.17</td>
<td>int</td>
<td>1.7</td>
<td>0.6; κ derived based on D&lt;sub&gt;crit,mean&lt;/sub&gt; (66.7 nm)</td>
<td>(Kuwata et al., 2007)</td>
</tr>
<tr>
<td>North Sweden 100s</td>
<td>100s</td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0.09</td>
<td>int</td>
<td>1.12</td>
<td>0.6; size-dependent κ derived based on HTDMA, CCN closure results reported for whole data set (aircraft data)</td>
<td>(Kammermann et al., 2010)</td>
</tr>
<tr>
<td>N American Coast Free troposphere</td>
<td>80-1000s</td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0.6</td>
<td>int</td>
<td>~1-1.5</td>
<td>0.6; size-dependent κ derived based on HTDMA, CCN closure results reported for whole data set (aircraft data)</td>
<td>(Roberts et al., 2010)</td>
</tr>
<tr>
<td>Northeast Atlantic</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>int</td>
<td>0.34</td>
<td>0.1; Better agreement in air masses with low aerosol loading and Rn</td>
<td>(Chuang et al., 2000)</td>
</tr>
<tr>
<td>Tasmania</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>int</td>
<td>1.26 (0.99)</td>
<td>0.5; Better agreement in air masses with low aerosol loading and Rn</td>
<td>(Covert et al., 1998)</td>
</tr>
<tr>
<td>North Pacific</td>
<td>0 &lt; κ&lt;sub&gt;org&lt;/sub&gt; &lt; 0.5</td>
<td>int</td>
<td>0.6 - 1.15</td>
<td>0.34</td>
<td>size-resolved</td>
<td>(Shantz et al., 2008)</td>
</tr>
<tr>
<td>Remote, marine</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0</td>
<td>int</td>
<td>0.92</td>
<td>0.38; size-resolved</td>
<td>(Bougiatioti et al., 2009)</td>
</tr>
<tr>
<td>Eastern Pacific</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0.0158</td>
<td>int</td>
<td>1.78</td>
<td>0.3; size-resolved</td>
<td>(Roberts et al., 2006)</td>
</tr>
<tr>
<td>Amazon</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0.6</td>
<td>int</td>
<td>0.2-0.3</td>
<td>0.2 - 1; size-resolved</td>
<td>(Mircea et al., 2002)</td>
</tr>
<tr>
<td>Amazon</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0.1</td>
<td>int</td>
<td>0.5-1</td>
<td>size-resolved composition</td>
<td>(Gunthe et al., 2009)</td>
</tr>
<tr>
<td>Amazon</td>
<td></td>
<td>κ&lt;sub&gt;org&lt;/sub&gt; = 0.03; int</td>
<td>1.11</td>
<td>0.3-1</td>
<td>2 internally modes of different sizes</td>
<td>(Rissler et al., 2005)</td>
</tr>
</tbody>
</table>

Fig. 1.