Temporal and spatial variations of CO$_2$ in Nanjing

3-SCALE OBSERVATIONS

2013.5.10
Temporal and spatial variations of $\text{CO}_2$ of street-level in Nanjing (Summer)

Temporal and spatial variations of $\text{CO}_2$ of street-level in Nanjing (Winter)

Temporal and spatial variations of $\text{CO}_2$ in fixed point observation in Nanjing (within mixed layer height)

Temporal and spatial variations of $\text{CO}_2$ in fixed point observation in Nanjing (mixed layer height)
Temporal and spatial variations of street-level CO$_2$ in Nanjing

Reporter: Wang Shumin
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Li Han Chao
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- Introduction
- Methods
- Results
- Discussion and summary
- Inspiration
**Introduction**

- Urban environments can change the local climate. The urban is net CO$_2$ source. They can affect the life of an increasing proportion of the world’s population that lives in and around cities *(Onil Bergeron, Ian B. Strachan, 2011)*.

- Among the largest carbon dioxide emitters in the world *(IEA, 2009)*, China has been considered responsible for two thirds of the global increase in anthropogenic carbon dioxide emissions of 3.1% in 2007 *(Yan and Yang, 2010)*.

- We observe Nanjing CO$_2$ concentration in order to quantify carbon emissions and calculate parameters for carbon models.
**Method**

- Experimental design:

Fig. 1. Schematic of selected lines in Nanjing taken from Google Earth
 Instrument: LI-840A CO$_2$/H$_2$O gas analyzer

 Time: 6/6 (THU)
       9/6 (SUN、Dragon Boat Festival)
       14/6 (FRI)
       15/6 (SAT)
       17/6 (MON)

       06:00:00  07:30:00  11:30:00  17:30:00  22:00:00
Process:

![AVI Video Screen Capture]

<table>
<thead>
<tr>
<th>Time</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>18:43:41</td>
<td>446.8926578</td>
</tr>
<tr>
<td>18:43:42</td>
<td>446.5125481</td>
</tr>
<tr>
<td>18:43:43</td>
<td>446.4025163</td>
</tr>
<tr>
<td>18:43:44</td>
<td>446.4725366</td>
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<td>18:43:46</td>
<td>446.872652</td>
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<td>18:43:47</td>
<td>447.0827127</td>
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<tr>
<td>18:43:48</td>
<td>447.2627646</td>
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<td>18:43:49</td>
<td>448.5231284</td>
</tr>
<tr>
<td>19:43:50</td>
<td>440.5224171</td>
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</tbody>
</table>
Results

Fig. 2. Diurnal variation of CO₂ concentrations of three days. Line 1 (a,b,c represents 0614,0615,0617, respectively.); Line 4 (d,e,f represents 0614,0615,0617, respectively.)
Fig. 3. Diurnal variation of CO$_2$ concentrations of three days.

Line 2 (g,h,i represents 0614,0615,0617, respectively.); Line 3 (j,k,l represents 0614,0615,0617, respectively.)
Fig. 4. Frequency distributions of CO$_2$ concentrations for line 1 and line 4
Fig. 5. Frequency distributions of CO$_2$ concentrations for line 2 and line 3
Fig. 6. Frequency distributions of CO$_2$ concentrations for each line
<table>
<thead>
<tr>
<th></th>
<th>06:00</th>
<th>07:30</th>
<th>11:30</th>
<th>17:30</th>
<th>22:00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Line 1</td>
<td>444.76</td>
<td>480.15</td>
<td>453.71</td>
<td>462.80</td>
<td>431.14</td>
</tr>
<tr>
<td>Line 4</td>
<td>434.19</td>
<td>478.54</td>
<td>452.89</td>
<td>458.41</td>
<td>430.56</td>
</tr>
<tr>
<td>Line 3</td>
<td>446.18</td>
<td>475.58</td>
<td>433.71</td>
<td>464.87</td>
<td>429.18</td>
</tr>
<tr>
<td>Line 2</td>
<td>423.28</td>
<td>454.67</td>
<td>430.10</td>
<td>441.90</td>
<td>412.07</td>
</tr>
<tr>
<td>ZSL</td>
<td>435.10</td>
<td>429.26</td>
<td>424.11</td>
<td>412.58</td>
<td>414.99</td>
</tr>
<tr>
<td>YF</td>
<td>385.78</td>
<td>373.02</td>
<td>381.03</td>
<td>355.88</td>
<td>357.583</td>
</tr>
</tbody>
</table>

**Tab. 1.** Average CO₂ concentrations (ppm) of four lines and two sites (ZSL and YF), a,b,c represent 0614, 0615, 0617, respectively.
Fig. 7. Average diurnal pattern of CO₂ concentrations (ppm) of two sites (XJK and ZSL), a, b, c represents 0614, 0615, 0617, respectively.
Fig. 8. CO$_2$ concentrations (ppm) for parking of line 4 (20130617_4_1)
Fig. 9. CO$_2$ concentrations (ppm) for parking of line 4 (20130617_4_2)
◆ Discussion and summary

- CO₂ concentrations showed obvious diurnal variation.

- Different lines had certain differences in frequency distributions during the three days.

- The highest values of each average CO₂ concentrations were not observed in the same time during the three days.

- The average CO₂ concentrations in daytime of XJK was higher than ZSL's, while the nighttime's values was opposite.

- We found that the higher CO₂ concentrations happened after parking which was not the same as we expected before.
◆ Inspiration

- We are not sure that the values we observed is representative and significant.

- We should be skilled in LI-840A in case of any emergency.

- Paper experimental records are very necessary, especially in these street-level tests.

- We should consider the differences among instruments before data processing.
Temporal and spatial variations of CO$_2$ in fixed point observation in Nanjing

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Introduction

- Urban ecosystem is the main source of CO₂ (Moriwakia, R., 2004) and the CO₂ emission is much higher than the suburbs and the natural landscape (Ziska et al., 2004; Zhao et al., 2010).

- Urban and suburban areas, despite covering only 2.4% of the earth’s surface (Potere et al., 2007), are responsible for over 80% of CO₂ emissions to the atmosphere (Turner et al., 1994).

- We observe Nanjing CO₂ concentration in order to quantify carbon emissions and calculate parameters for carbon models.
Method

- Instrument: LI -840A CO₂/H₂O gas analyzer
- Time: 20130628(14:00)~20130804(14:00)
  20130804(15:30)~20130805(15:30)
- Measurements sites:
  Xinjiekou(9F)
  Bailuzhou(5F)
  Jiuxiaoqu(5F)
  Shengjunque(7F) & Hehai(4F)
  Xinxiaoqu(3F)
(a) Schematic of measurement sites location

(b) Surrounding environment of measurement sites

Fig. 1. Map of Nanjing around the measurement sites taken from Google Earth
Results

Fig. 2. Frequency distributions of CO$_2$ concentrations of six measurement sites (0728_14:00~0804_14:00)
Fig. 3. Weekly pattern of CO$_2$ concentrations for the entire study (0728_14:00~0804_14:00)
Tab.1. Average CO$_2$ concentrations (ppm) of five measurement sites

<table>
<thead>
<tr>
<th></th>
<th>total</th>
<th>weekday</th>
<th>weekend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xinjieku</td>
<td>417.4623</td>
<td>419.1034</td>
<td>412.4839</td>
</tr>
<tr>
<td>Xinxiaoku</td>
<td>412.4136</td>
<td>414.1008</td>
<td>411.4503</td>
</tr>
<tr>
<td>Jiuxiaoku</td>
<td>411.0746</td>
<td>413.2485</td>
<td>404.5179</td>
</tr>
<tr>
<td>Hehai</td>
<td>409.1151</td>
<td>411.064</td>
<td>405.7072</td>
</tr>
<tr>
<td>Bailuzhou</td>
<td>396.9968</td>
<td>398.4507</td>
<td>392.7355</td>
</tr>
</tbody>
</table>
Fig. 4. Average diurnal pattern of CO₂ concentrations for the weekdays

The CO₂ concentrations showed a clear diurnal pattern. The highest concentrations occurred between 6:00 and 8:00 with a range from 420 to 445 ppm. The lowest CO₂ concentrations were observed during afternoon.
Fig. 5. Average diurnal pattern of CO$_2$ concentrations for the weekends

The CO$_2$ concentrations showed a clear diurnal pattern. The highest concentrations occurred between 7:30 and 9:00 with a range from 410 to 440 ppm. The lowest CO$_2$ concentrations were observed during afternoon.
Fig. 6. Average diurnal pattern of CO$_2$ concentrations of two sites in Xinjiekou 20130804_15:30~20130805_15:30

These two sites’ diurnal pattern shared the same trend and Road ’s concentration is 18.6 ppm higher than the Market ’s on average. Three daily average values of CO$_2$ concentration from different heights were 474.6ppm(street), 396.3ppm(Market) and 414.9ppm(Road).
Discussion and summary

Consistent with the expected, in the different underlying surface s, \( \text{CO}_2 \) concentrations showed certain differences and some of them were significant. In our experiment, Xinjiekou 's concentrations were the highest and Bailuzhou 's were the lowest.

Traffic had certain contribution to carbon emissions, but we were not sure whether the '18.6 ppm' were the true value come from traffic emissions.

We still doubt whether the heights we chose were suitable.
**Inspiration**

It is necessary that the instrument needs to be checked regularly. It may stop working, record the same value which is obviously wrong, record wrong date and so on.

We should be good at calibration process in case of something unexpected like screw slippery of pressure-reducing valve.

Something wrong with calibration which we cannot explain.

We should consider the differences among instruments before data processing.
Thank You