Study of total lightning data: preliminary result

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Outline

• Brief of lightning data
• General characteristics of total lightning
• Cases analysis
• Conclusion
1. Total lightning activity tends to follow the trend in updraft (Williams et al. 1989).

2. The rapid increases in the total flash rate, termed lightning jumps, are indicative of updraft intensification, have been observed to occur as severe weather manifests within the storm (Gatlin and Goodman 2010).

3. The trends in total lightning are more robustly correlated to severe weather occurrence, with rapid increases in total lightning observed 10s of minutes prior to the onset of severe weather (Schultz et al. 2011).
Brief of total lightning data (private discussion with Tai-power engineer)

1. Before 2004, the lightning data contains only one type: cloud-to-ground from Lightning Detection System.

2. After 2004, there are 6 types in Total LDS:
   - TYPE 0: single intra-cloud (IC)
   - TYPE 1: start point of consecutive IC
   - TYPE 2: middle point(s) of consecutive IC
   - TYPE 3: end point of consecutive IC
   - TYPE 4: cloud-to-ground (CG)
   - TYPE 5: step strikes of cloud-to-ground

OPERATIONAL USE OF LIGHTNING DETECTION METHODS
3. To distinguish the flash from IC and CG is based on the 
   quantify of current. (CG larger than IC of $O(1) \sim O(2)$)

4. IC is positioned by high frequency of electric pulse.

5. The CG position error is about 1km, but the position error 
   of IC is unknown and (mostly) larger than CG.

6. The detect system is upgrading, the IC data quality will 
   increase after 2014.
General characteristics of total lightning

Number of TSa days during 2007-09. (L)type0, (M)type1, and (R)CG
Total lightning (1 x 1 km total lightning)
Cases analysis

Data analysis processes

1. **QPESUMS**: 10-min interval, 23 CAPPI levels (using CV), 0.0125° × 0.0125° horizontal resolution, lon. 118°E~123.5°E, lat. 20°N~27°N (441 × 561)

2. **TLDS**: 2 types lightning data (IC, CG) same with QPESUM region integrated from 10 min. before

QPESUMS: 00:00Z~23:00Z, time=139
LTN data: 00:10Z~24:00Z, time=144
ICFR: number of IC in one time step (past 10 min)
DFRDT(IC): time rate of ICFR
Case analysis: 8/15/2008

ICFR: number of IC in one time step (past 10 min) ; DFRDT(IC): (IC\textsubscript{t} - IC\textsubscript{t-10})/2
Case analysis: 6/16/2008

[Graph and chart showing data trends labeled with various acronyms and numbers.]
Case analysis: 9/15/2009

NC

C
application of lightning jump of a nontornadic severe storm (Galtin and Goodman 2010)

application of lightning jump of severe wind produced by thunderstorm (Schultz 2011)
<table>
<thead>
<tr>
<th>cases</th>
<th>jump</th>
<th>Leading (in minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/15/2008 (N)</td>
<td>3 → 91</td>
<td>10~30</td>
</tr>
<tr>
<td></td>
<td>20.5 → 65.5</td>
<td>10~20</td>
</tr>
<tr>
<td>8/15/2008 (NC)</td>
<td>2.5 → 78.5</td>
<td>0~30</td>
</tr>
<tr>
<td></td>
<td>9.5 → 86</td>
<td>10~20</td>
</tr>
<tr>
<td>8/15/2008 (C)</td>
<td>no significant jump</td>
<td></td>
</tr>
<tr>
<td>6/16/2008 (N)</td>
<td>2.5 → 36</td>
<td>20~40</td>
</tr>
<tr>
<td></td>
<td>43.5 → 65.5</td>
<td>20</td>
</tr>
<tr>
<td>9/15/2009 (NC)</td>
<td>12.5 → 29.5</td>
<td>20~30</td>
</tr>
<tr>
<td>9/15/2009 (C)</td>
<td>1.5 → 25</td>
<td>20~40</td>
</tr>
</tbody>
</table>
Conclusions

At least, for the selected three afternoon thunderstorms:

- CG lightning is of very limited use.

- IC lightning jump leads the maximum of CV for thresholds $\leq 50$ dBZ.

- Chasing the time rate of total lightning rate could benefit the identification of intensity evolution.