A short analysis of lightning data from meteoLCD

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Version 1.01 25 September 2013

Abstract:
This is a very short analysis of lightning data collected at the meteorological station of the Lycée classique Diekirch, Luxembourg from May 2009 to September 2012. The Noise to Signal ratio is fair and the statistics of IC/CG flashes are close to those given in the literature with a possible excess of the CG+ count.

1. The equipment and it’s characteristics

meteoLCD uses a BOLTEK Storm Tracker system [1] installed in June 2003 to detect and locate thunderstorms and lightning flashes. This system is based on a special PCI card and an external antenna system. The PCI card is managed by specific Boltek drivers and the Lightning 2000 software from Aninoquisi [3], both running on a dedicated computer. The Stormtracker has a range exceeding 300 miles (almost 500 km) and is able to locate the lightning type, position and direction. Lightning types include CG (cloud to ground) and intracould (IC) flashes, positive or negative. The accuracy of the Boltek detector is determined by many factors - placement of the detector, electromagnetic interference, distance from flashes, storm intensity …

The antenna system is a dual antenna module mounted in a single enclosure. This means that the location accuracy can not match that of the very expensive multi-antenna systems like those of the Siemens BLIDS system [2]

The Lightning 2000 software has been upgraded at regular intervals. The data given in this paper correspond to version 4.x and above.
Fig. 1. Antenna system of the Boltek Storm Tracker. The antenna module is mounted inside a PVC tube for rain and environmental protection.

2. The records

Several types of records are available:

1. An archive holds all lightning activity and allows, using a player specific to the L2k software, to play back archived records which are in a proprietary format. This play back displays among others a daily summary of the totals and various types of flashes.
Fig. 2. Lightning summary given by the L2K archive player for the 10 June 2004, a day of exceptional heavy thunderstorm activity.

2. meteoLCD has written special software that makes a daily mpg movie out of the minutely screen dumps from the computer running L2K; there is a lower limit (usually 60 flashes per hour) that must be exceeded for making these videos (see [http://meteo01.lcd.lu/~lightning/previous_days_lightning/](http://meteo01.lcd.lu/~lightning/previous_days_lightning/)).

The following table shows the daily summaries for the period from 13 May 2009 to 29 Aug 2012, omitting days without data..

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Short analysis of meteoLCD lightning data
Several important results are:

1. The **Noise to Signal ratio** given in the right-most column shows a maximum of 0.0228 or about 2.3% which is a fair value. A noise is defined as any electrical discharge that cannot be positively identified as a lightning flash. Noises include electrical noise from household appliances, signals transmitted by wireless electronic devices, and lightning strokes that have an insufficiently well-defined waveform.

2. The average of the **fraction IC/CG** ((intra-cloud) to (cloud to ground) flashes) is $2 \pm 0.83$ where 0.83 is the standard deviation. We may compare these results to those given in the Höller et. al paper [4] for a storm cell. In this paper the fraction IC/CG at the maximum of storm activity is $175/75 = 2.3$, close to the average given above for the long-term meteoLCD data (fig. 3).

3. The percentages of the three categories IC, CG and noise are ~63%, ~37% and 0.8% (fig. 4).

4. Negative CG flashes outnumber by a factor of ~2.6 positive cloud to ground flashes. The average and standard deviation of the fraction CG-/CG+ is $2.72 \pm 1.62$. This relatively high positive CG count might be surprising, as figure 2 shows that the CG+ flashes represent only ~18% of the total CG's during a very strong thunderstorm (see [5]). One should remember that the fraction of 2.72 represents an average of all type of storms observed, small and intense.
5. Negative inter/intra cloud flashes also are more frequent then positive ones. The average and standard deviation of the fraction $IC-/IC^+$ is $2.12 \pm 1.21$

In total negative flashes represent approx. 64% and positive 36% of the IC + CG total.

**Fig. 3.** Maxima of flash types in a storm cell during a severe thunderstorm. Adapted from [4]

**Fig. 4.** Pie chart of the noise and flash type frequencies (in percent)
4. Storm days and relation with air temperature

The following table shows the number of days where the flash total is greater than 10000; this arbitrarily chosen number will be used to classify a day as a thunderstorm day. Only the months May to August will be retained; as the noise counts are small, they will not be subtracted from the totals.

<table>
<thead>
<tr>
<th>Year (May to August)</th>
<th>days with flash count &gt; 10000</th>
<th>total of flashes</th>
<th>Mean air temperature °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>9</td>
<td>267314</td>
<td>16.81</td>
</tr>
<tr>
<td>2011</td>
<td>10</td>
<td>321235</td>
<td>17.03</td>
</tr>
<tr>
<td>2012</td>
<td>10</td>
<td>289042</td>
<td>17.09</td>
</tr>
</tbody>
</table>

No clear trend is visible from these 3 years. Even if the totals differ by about up to 20%, the number of storm days is practically the same, and no relation with mean air temperature shows up. A further analysis extending over a much longer period could possibly give some hints on a possible influence of mean air temperature on the observed frequency of thunderstorms and flash count.

5. Conclusion

The BOLTEK Storm Tracker together with the Lightning 2000 software is a rather inexpensive device for locating thunderstorms and analysing flash count and flash types. In use since 2003 at the meteorological station of the Lycée classique Diekirch (http://meteo.lcd.lu) it allows an easy analysis of the frequencies of cloud to ground and inter/intra cloud lightning and of their polarities. The results from a three year period 2010 to 2012 show that negative flashes outnumber positive ones by more than 2, and inter/intra cloud flashes are nearly 3 times more frequent than cloud to ground flashes. The number of observed positive CG flashes seems rather high in the global count, as it is usually assumed that CG+ flashes represent not more than 10% of the totals. The detection efficiency of the Boltek/Lightning 2000 equipment is unknown.[6]. Future studies should extend on longer periods and use precipitation volume during storm days for an analysis of an eventual correlation with CG+ percentage [6].
References:

1. http://www.skyview.co.uk/acatalog/STORMTRACKER.html
5. Mathias, L.: Analysis of thunderstorm and lightning activity in the Greater Region (Part 2) (link)