Cloud-to-ground lightning activity in Portugal: overall characterization, spatial and temporal patterns of associated thunderstorms over the 2003-2009 period

Fragoso, M.¹; Correia, S.¹; Leite, S.²; Santos, J.²; Sousa, J.³

(1) Centre for Geographical Studies, IGOT, University of Lisbon, Portugal
mfragoso@campus.ul.pt
(2) UTAD, CITAB, Physics Department, Vila Real, Portugal
(3) Meteorological Institute, Lisbon, Portugal
Outline

• Introduction

• Overall characterization of CG lightning activity over Portugal, 2003/2009 period (brief synthesis)

• Classification of spatial and temporal patterns of CG lightning events in Portugal (preliminary results)
  – The method
  – Preliminary results

• Conclusions and further work
The Portuguese Lightning Location System
4 sensors IMPACT-141-ESP in Portugal
(5 sensors in Spain)
Overall characterization of CG lightning activity over the 2003/2009 period

Mean flash density (2003-2009), flashes year$^{-1}$, km$^2$
(grid resolution 10x10 km)

• Maxima: > 0.4 CG flashes/km$^2$ year$^{-1}$
  - Southern Alentejo
  - Central and North-Eastern Portugal
Overall characterization of CG lightning activity over the 2003/2009 period
Diurnal rhythm of CG lightning (total number of CG flashes)
This investigation aims to perform an identification of thunderstorm events and, subsequently, to classify the spatial patterns of the associated CG flashes (Murphy and Konrad, 2005, Monthly Weather Revue, 1417-1430)

- "Which" thunderstorms events?

- A sample of days with CG lightning flashes in Portugal was considered, selecting only those whose CG flashes occurrences exceed the 50th percentile (25 flashes):

  376 days over the 2003-2009 period
“How” was identified each thunderstorm event?

- By the temporal clustering of CG flashes into separated lightning events. Events were initiated by the first occurrence of a CG lightning flashes (begin phase) and terminated when one or more hours elapsed without a single lightning strike (end phase).

- The mature phase of the event was identified as the hour period in which the greatest number of CG flashes was observed.

- Therefore, each thunderstorm event was classified according to the spatial pattern of CG flashes at the mature phase (hour with the greatest number of CG flashes).
• “How” were classified the spatial patterns of CG flashes (maturity phase)?
• “How” were classified the spatial patterns of CG flashes (maturity phase)?

Classification criteria:

- **size of the affected area** (in km², estimated by the polygon area)
- a **single** affected area or **more than one**?
- **spatial pattern** of flashes within the region of flash activity (shape of the polygon)

CG flashes spatial patterns

- **Local** thunderstorm events (< 1/6 of the PT area)
- **Multilocal** thunderstorm events (< 1/6 of the PT area)
- **Regional** thunderstorm events (< 2/3 of the PT area)
  - **Linear** thunderstorm events (dRatio <0.7)
  - **Eliptical** thunderstorm events (dRatio>0.7)
- **Widespread** thunderstorm events (>2/3 of the PT area)
Spatial and temporal patterns of thunderstorms in Portugal (2003-2009)

- **Local**
  - 16h 09.05.2009

- **Multilocal**
  - 15h 09.05.2008

- **Regional / linear**
  - 12h 16.02.2007

- **Widespread**
  - 14h 16.06.2006
Preliminary results: **Frequency of types of thunderstorm events (%)**

- Local: 48%
- Multilocal: 36%
- Regional: 16%
- Widespread: 1%
Preliminary results: relative frequency of the four main spatial patterns

February:
- Local: 55
- Multilocal: 35
- Regional: 10
- Widespread: 0

May:
- Local: 41
- Multilocal: 41
- Regional: 0
- Widespread: 0

June:
- Local: 63
- Multilocal: 26
- Regional: 8
- Widespread: 3

September:
- Local: 46
- Multilocal: 31
- Regional: 23
- Widespread: 0
Preliminary results: **Mean number of CG flashes per thunderstorm event**

![Chart showing the mean number of CG flashes per thunderstorm event, classified by type: Local (293), Multilocal (445), Regional (1698), Widespread (4306).]
Preliminary results: Typical (mean) area affected by CG flashes (km$^2$)
Preliminary results: **Mean duration (hours) of thunderstorm events (%)**

- Local: 6
- Multilocal: 7
- Regional: 13
- Widespread: 12
Conclusions and further work

- It was shown that thunderstorms in Portugal exhibit a higher frequency in the interior areas, except during winter.
- A method of classification of the spatial patterns of CG discharges within regions affected by thunderstorms was carried out.
- Four main categories: local, multi-local, regional and widespread thunderstorm events.
- This classification should be useful to identify the thunderstorm events responsible for major impacts over the Portuguese territory (a task under the Raiden project).
- We are also interested to investigate the relationship between these different types of thunderstorms and the associated atmospheric situations.