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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

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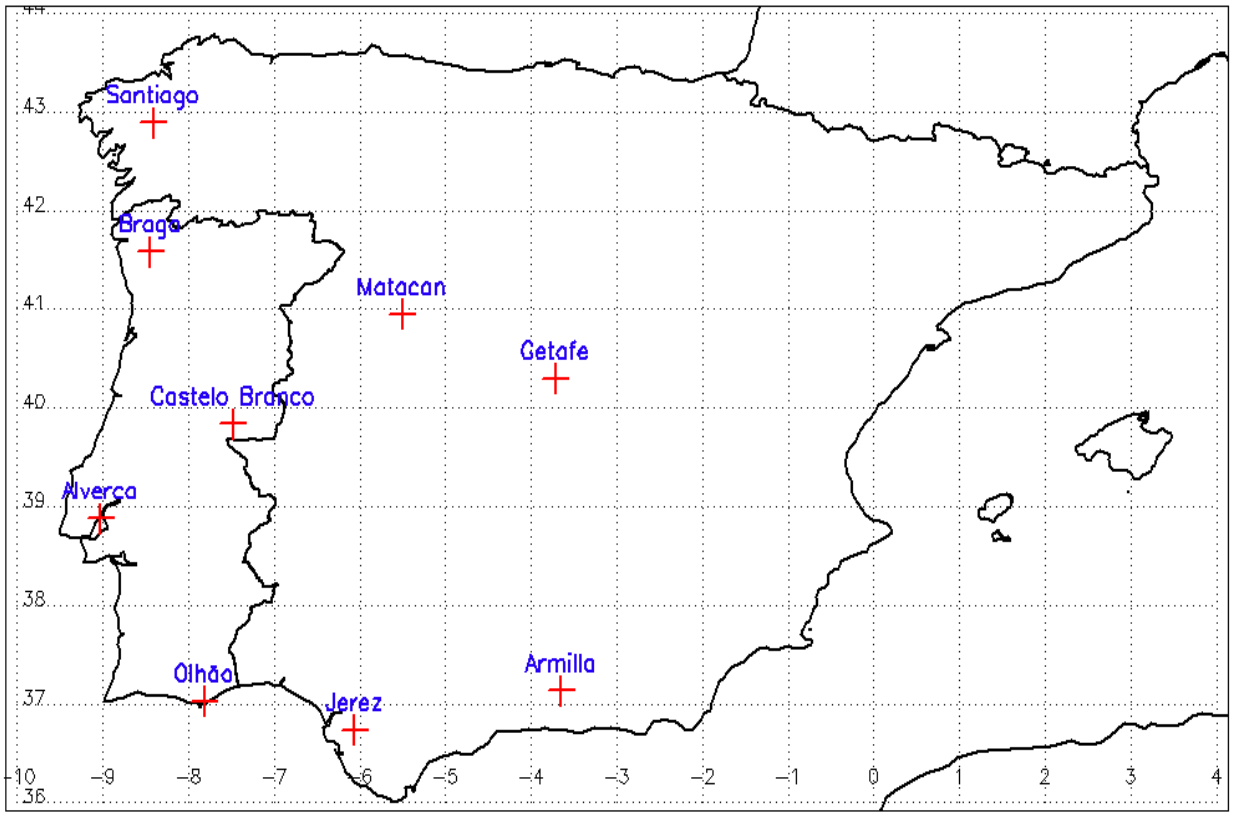
Outline

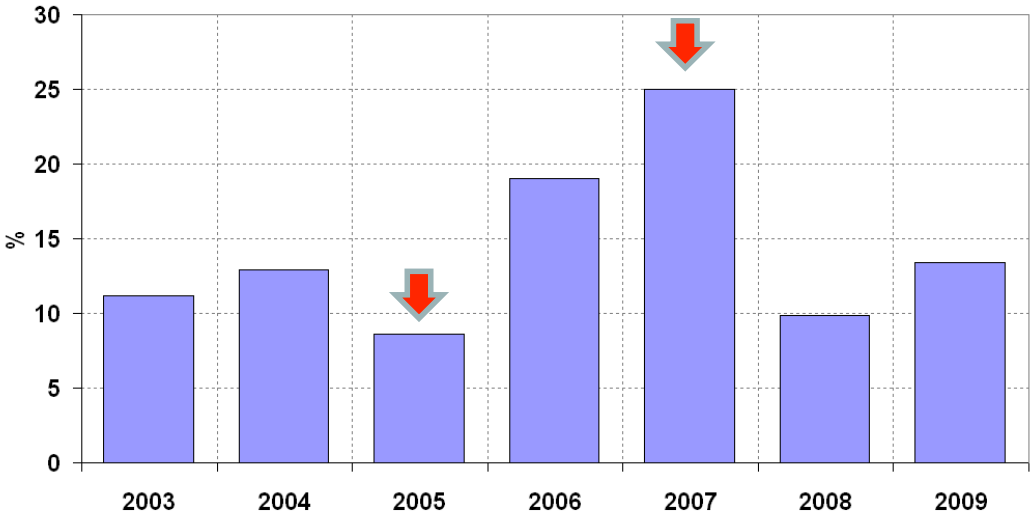
- Introduction
- Overall characterization of CG lightning activity over Portugal, 2003/2009 period (brief synthesis)
- Classification of spatial and temporal patterns of CG lightning events in Portugal (preliminary results)
  - The method
  - Preliminary results
- Conclusions and further work

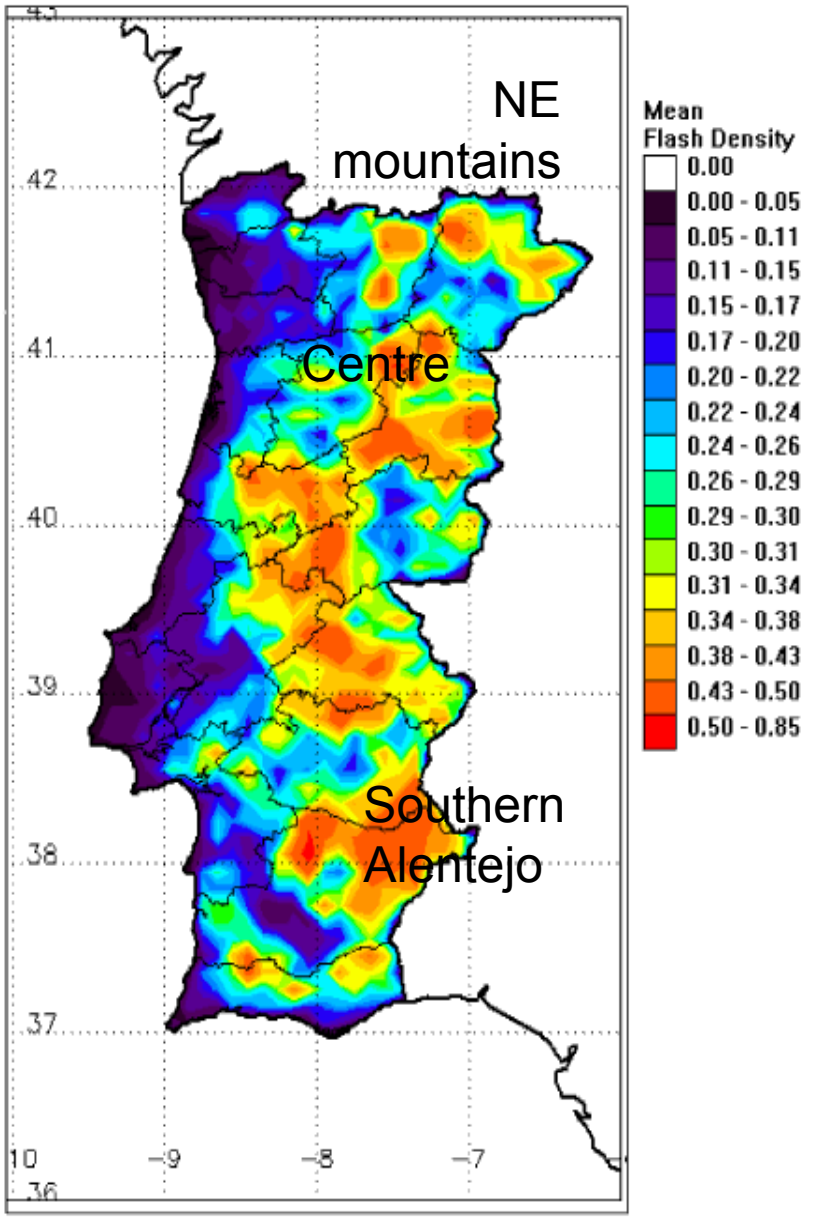
The Portuguese Lightning Location System
4 sensors IMPACT-141-ESP in Portugal
(5 sensors in Spain)



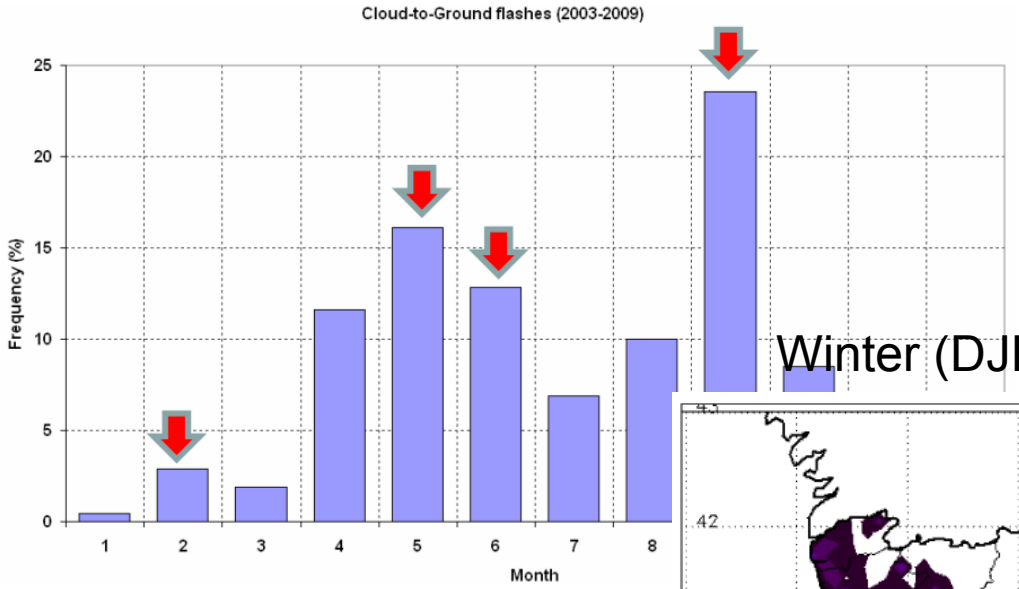
Mean flash density (2003-2009), flashes year^{-1}, km^2
(grid resolution 10x10 km)

- Maxima: > 0,4 CG flashes/km^{2}year^{-1}
  - Southern Alentejo
  - Central and North-Eastern Portugal

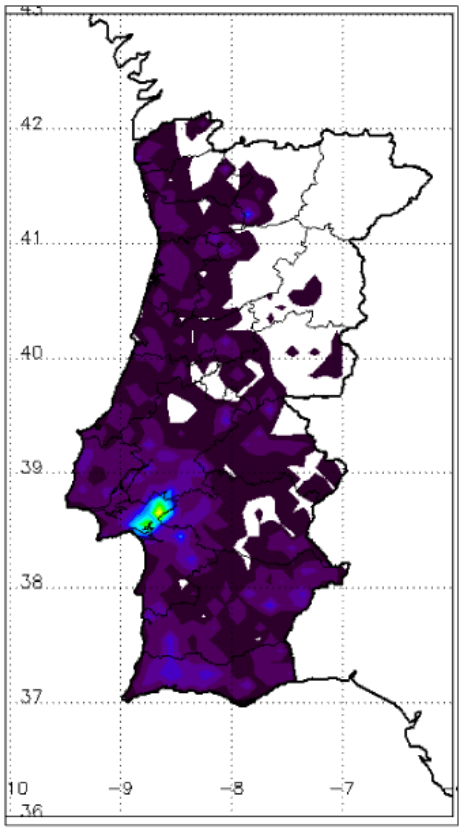




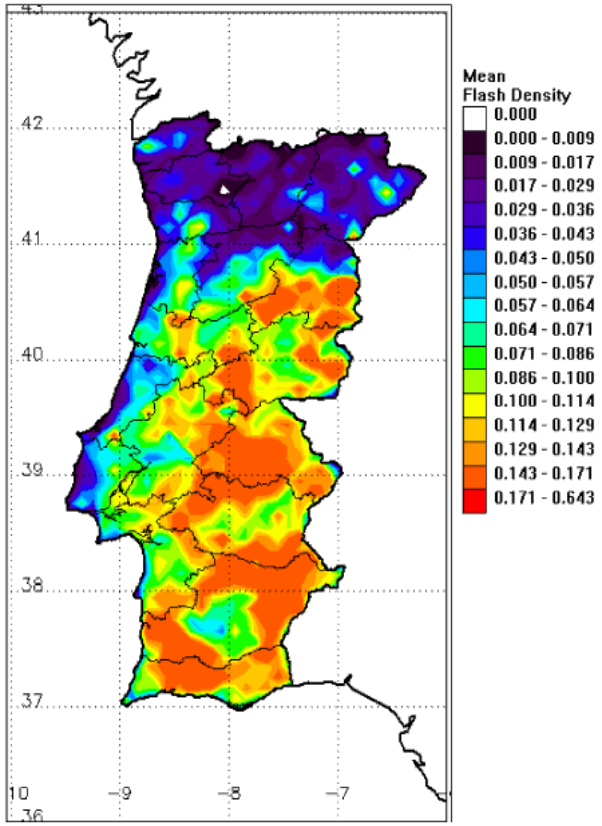
Overall characterization of CG lightning activity over the 2003/2009 period . 5.17



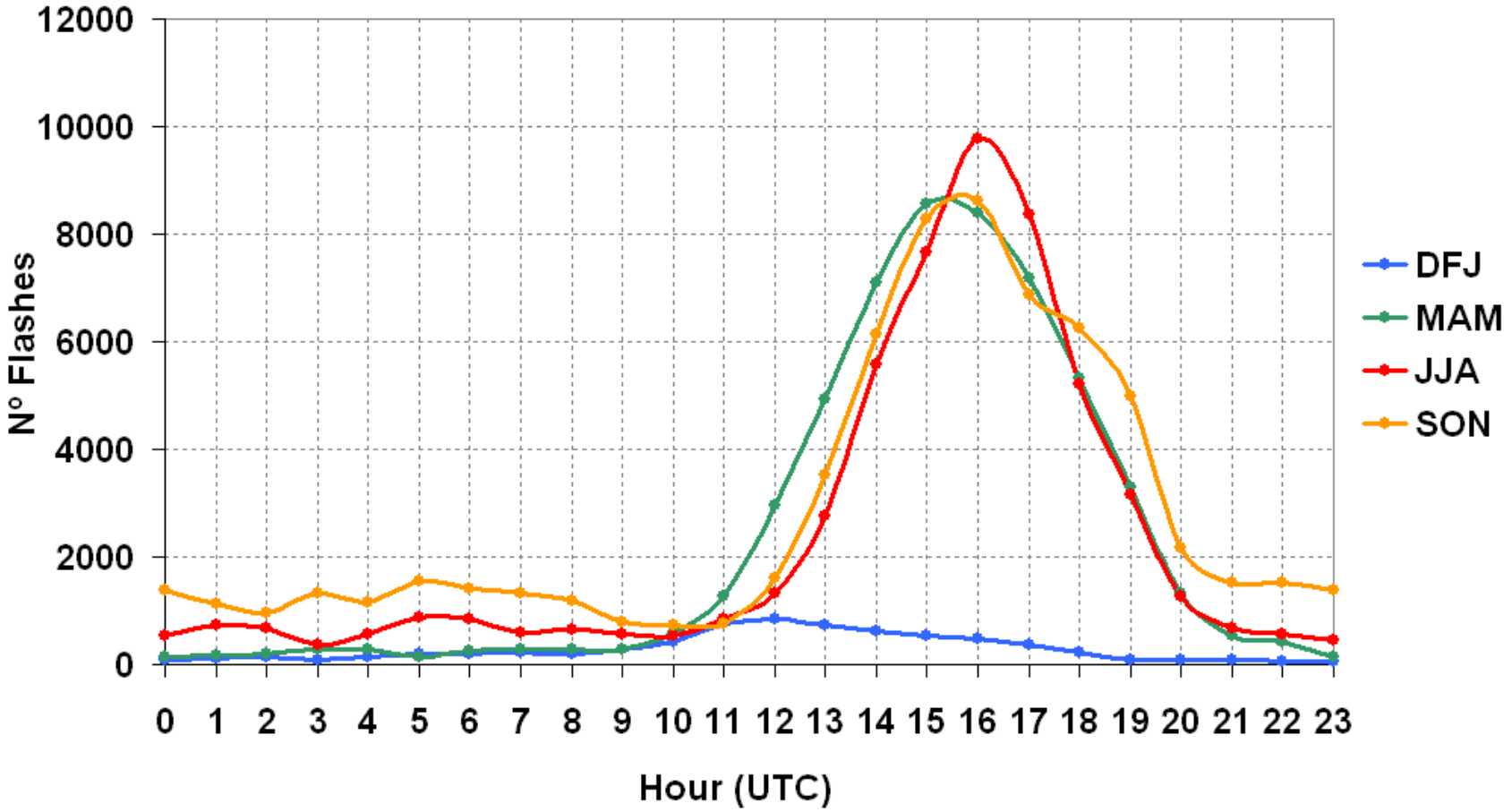
Winter (DJF)



Autumn (SON)



Diurnal rhythm of CG ligtning (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

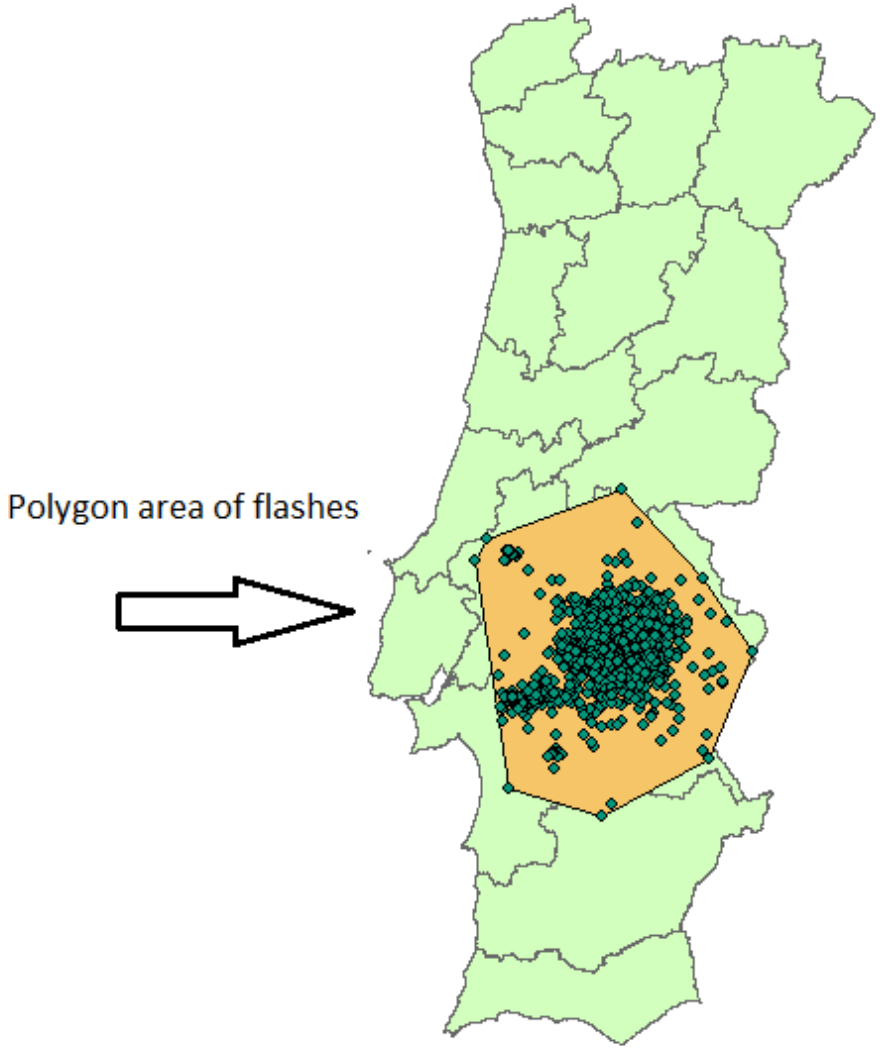
• "***How***" was identified each thunderstorm event?

- 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 km^2, estimated by the polygon area)

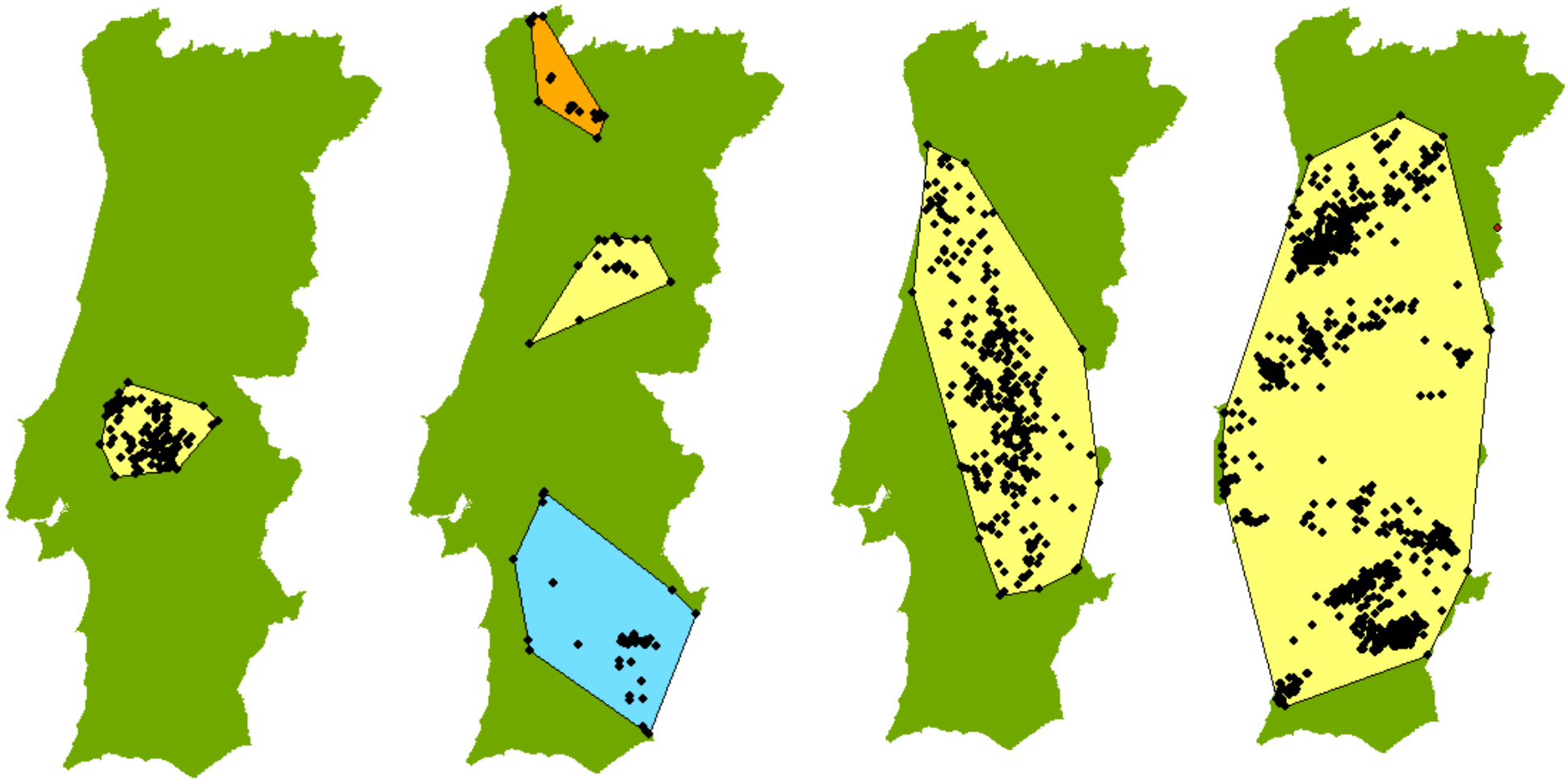
- a **single** affected area or **more than one**?

- 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) . 11.17



Local

16h 09.05.2009

Multilocal

15h 09.05.2008

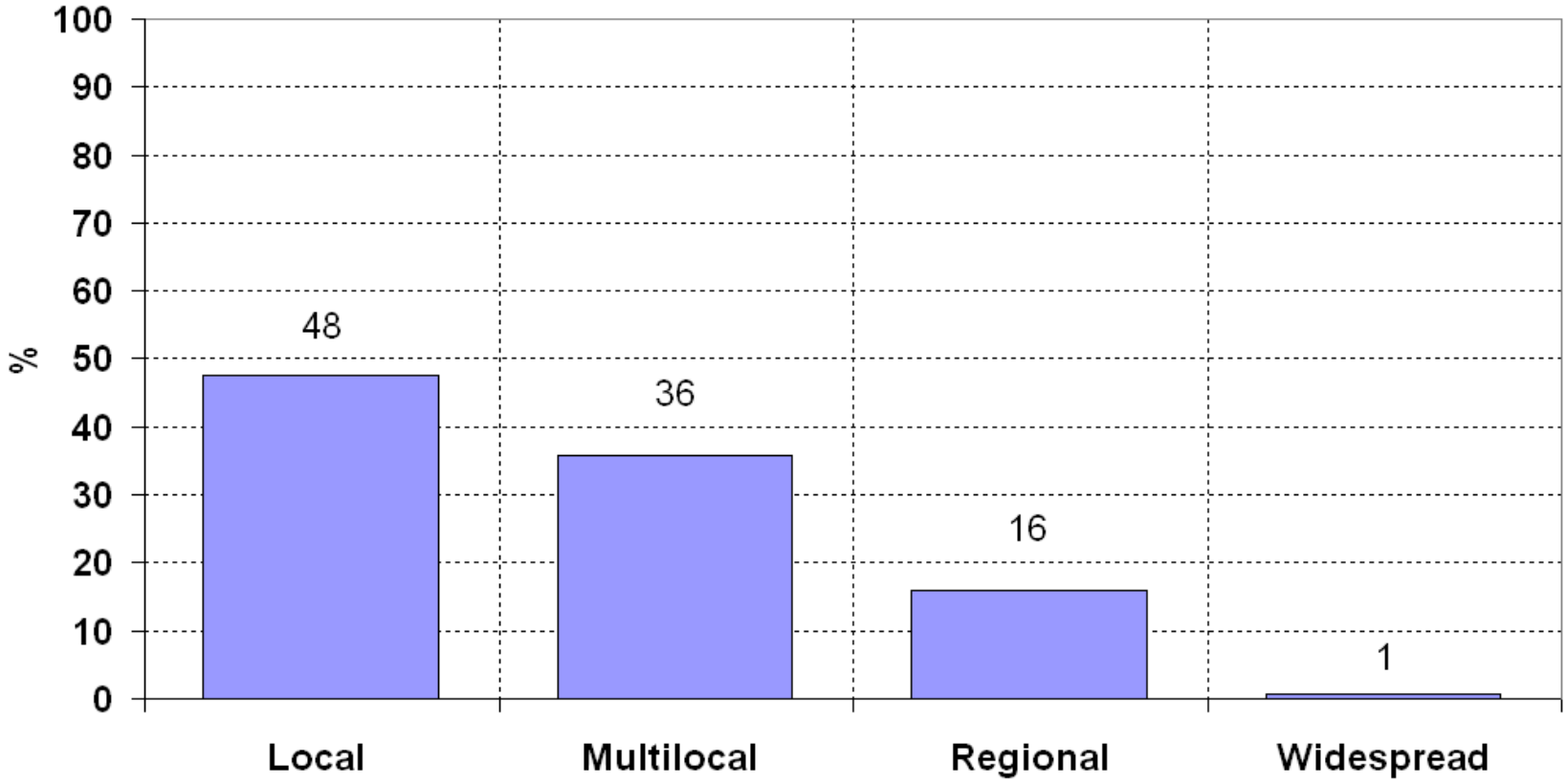
Regional / linear

12h 16.02.2007

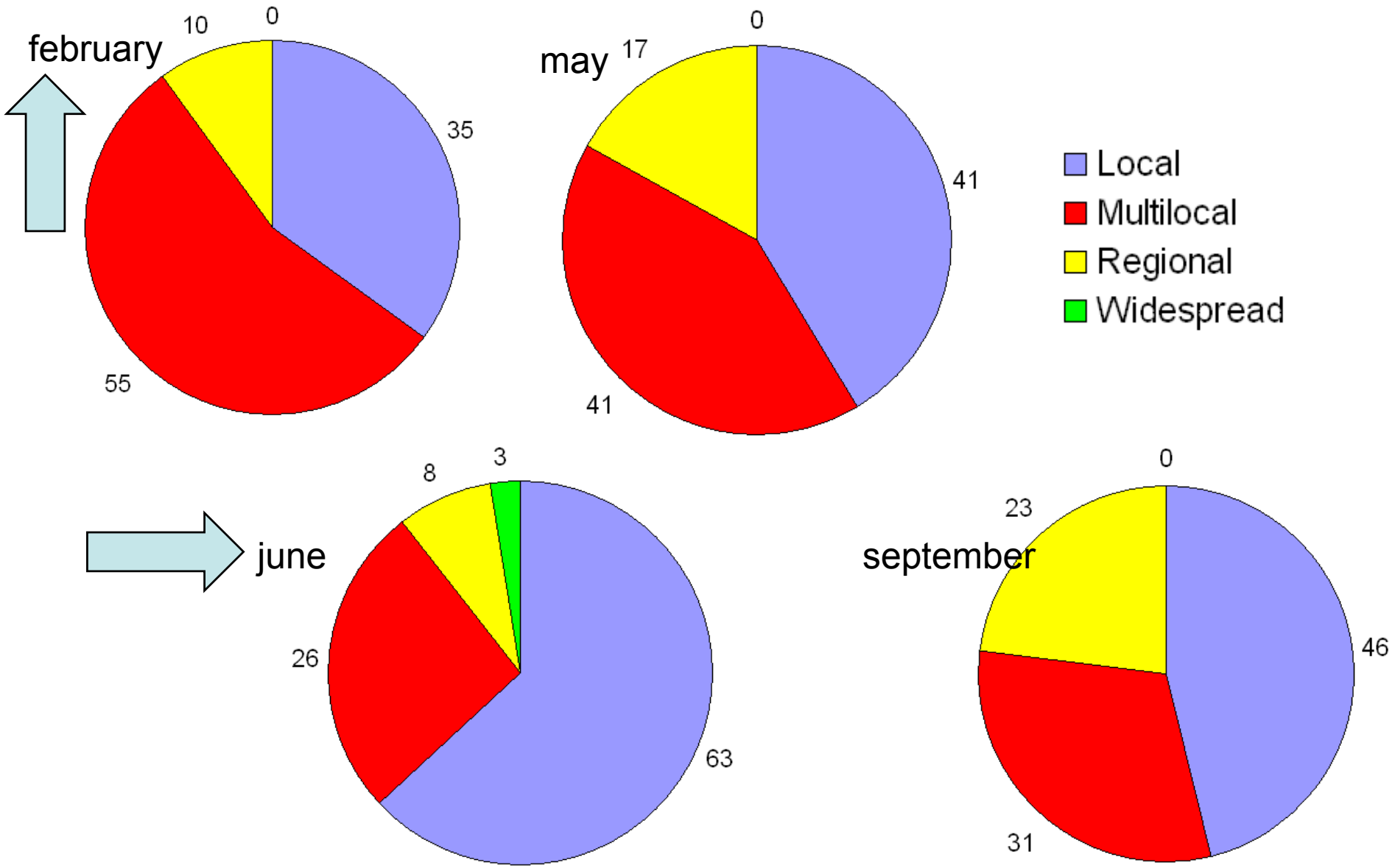
Widespread

14h 16.06.2006

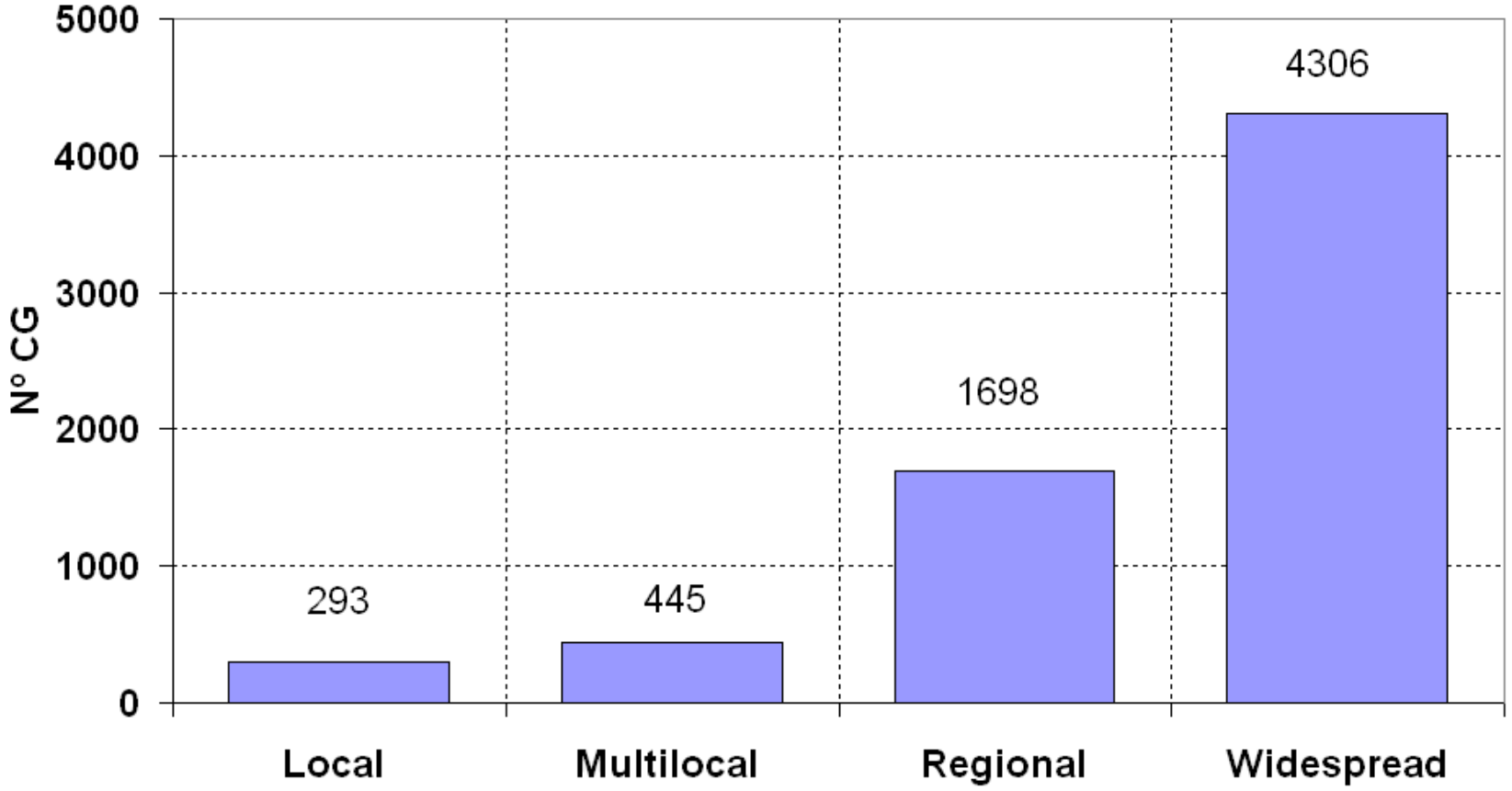
Preliminary results: **Frequency of types of thunderstorm events** (%)



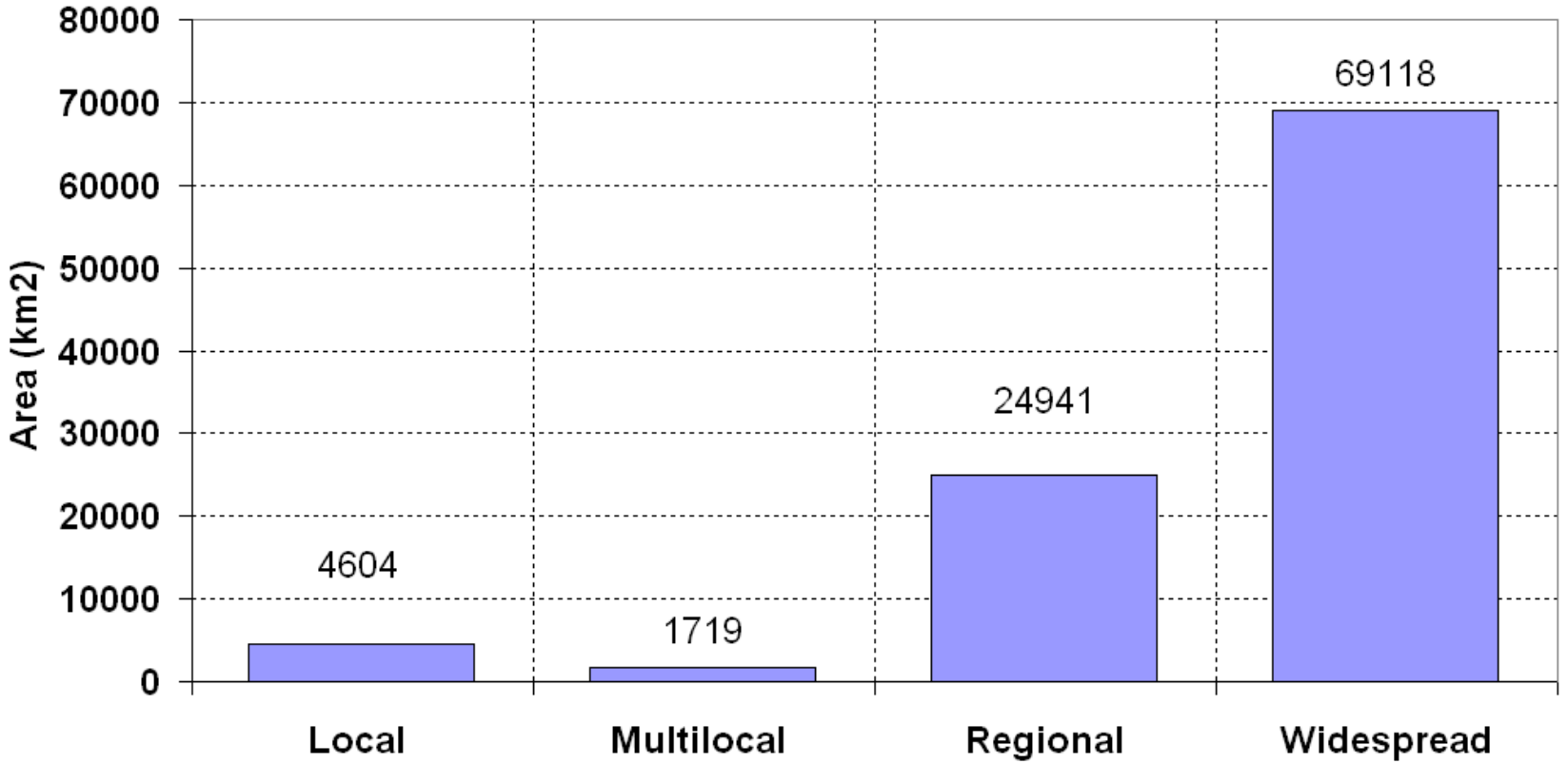
Preliminary results: **relative frequency of the four main spatial patterns**



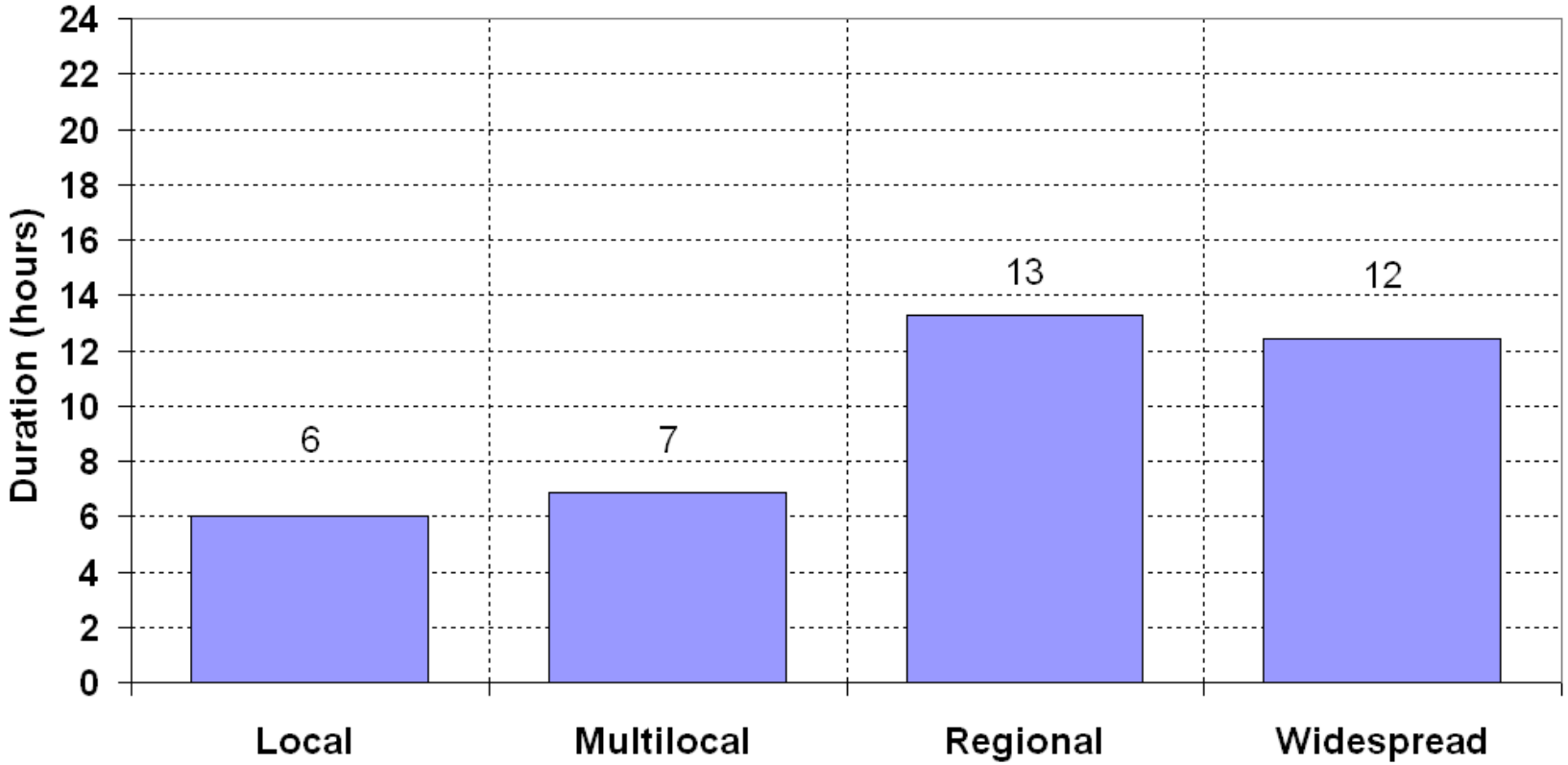
Preliminary results: **Mean number of CG flashes per thunderstorm event**



Preliminary results: **Typical (mean) area affected by CG flashes (km^2)**



Preliminary results: **Mean duration (hours) of thunderstorm events** (%)



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.