FOUR YEAR LIGHTNING CLIMATOLOGY IN THE BASQUE COUNTRY

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I. INTRODUCTION

In this work we present a four year "climatology" of the cloud-to-ground (CG) lightning strokes detected in the region of the Basque Country (NE of Spain) since 2009.

Total lightning detection in Basque Country has been performed since November 2008, based on a LS8000 sensor network. Today the combination of a four LF/VHF sensor network and four LF/VLF Linet sensors provides two independent sources of information for cloud-to-ground and intra-cloud lightning discharges in Basque Country.

The LS8000 network, operating since November 2008, combines LF and VHF subsystems. Detections in the LF frequency band are performed using the combined technique TOA plus Magnetic Direction Finding. VHF detections are performed using the interferometry technique.

By mid May 2009 four sensors of the Linet network started their operation in the Basque Country, using the VLF/LF frequency bands for total lightning detection.

Usually, the detected events are located, measured and then correlated in order to obtain an accurate dataset of validated data. The purpose of total lightning detection (TLD) in Basque Meteorology Agency (Euskalmet) is twofold: real-time monitoring of severe weather episodes and offline studies for "climatology" and forensic aspects.

II. TOTAL LIGHTING DETECTION NETWORKS

The Basque Meteorology Agency (Euskalmet), at present time, counts on two independent lightning detection systems.

Four LS8000 sensors manufactured by Vaisala integrate the Euskalmet network. In these sensors two detection technologies are combined:

- Time of arrival (TOA) and magnetic direction finding (MDF) in the LF frequency band are used for detecting cloud to ground (CG) lightning discharges.
- The interferometry technique is used for detecting radiation sources in the VHF frequency band. This technology is used for detecting intracloud (IC) discharges.

On the other hand, four sensors of the LINET network were installed in the Basque Country in 2009. These sensors perform detections in the VLF frequency band, and provide data relative to Cloud to ground (CG) and intracloud (IC) discharges, with an estimation of the height at which these last ones occur.

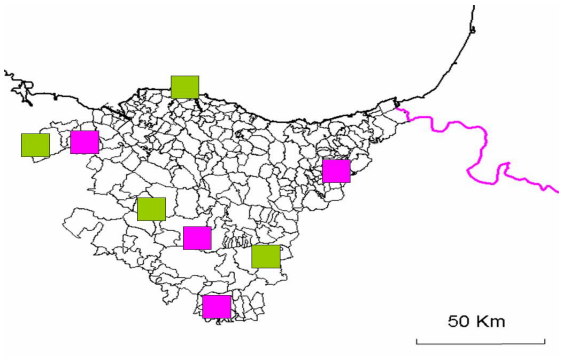

FIG. 1 Distribution of the LF/VHF sensors (green) and the VLF/LF sensors (pink)

III. LIGHTING DATA

In the VLF/LF network case availability of data is based on text files with the activity registered by the network each minute and an online client for visualization.
LF/VHF network system provides raw data locally stored in the sensors and raw data files.

Some products files and representation tools are available from those systems in order to analyze data. Including a CG event database that can be requeried for further analysis of thunderstorm episodes and online representation of CG impacts and VHF sources over a GIS.

Some data quality studies are done. In particular, time correlations between the CG events detected by the two systems are obtained for time differences less than 1 millisecond and presented offline in Google Earth. This representation allows a quick overview of the entire territory focusing on certain groups of lightning discharges that may have affected particular areas.

Regarding the information retrieved by the lightning detection networks since 2009, and focusing on Cloud to ground (CG) data in FIG 2 to FIG 5 we present the number of strokes for CG lighting detection segmented by year and month. As a summary we can observed in FIG 6 an interannual representation by moth of CG strokes, and total strokes for four years analyzed in FIG 7.

In FIG 8 we can see the percentage of positive strokes for 2009, 2010, 2011 and 2012 years and in FIG 9 the percent of strokes below 20 kA segmented in positive and negative for the four studied years.

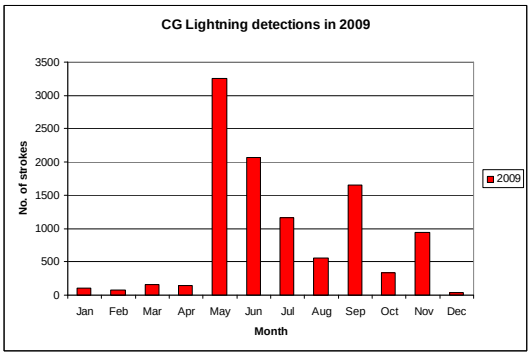

FIG. 2 Number of CG impacts by month in 2009 year.

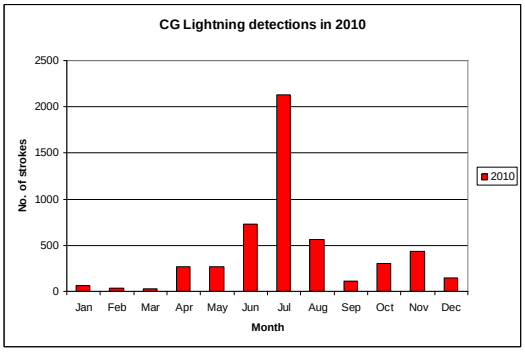

FIG. 3 Number of CG impacts by month in 2010 year

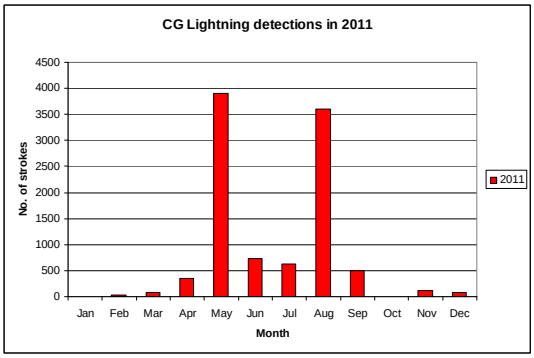

FIG. 4 Number of CG impacts by month in 2011 year.

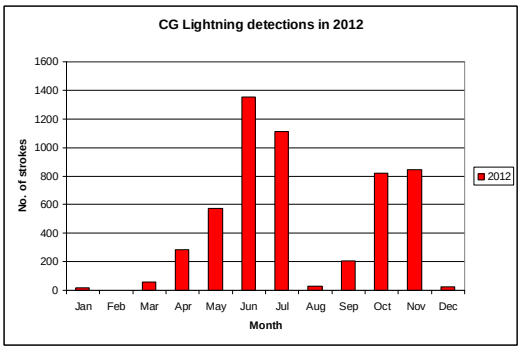

FIG. 5 Number of CG impacts by month in 2012 year.

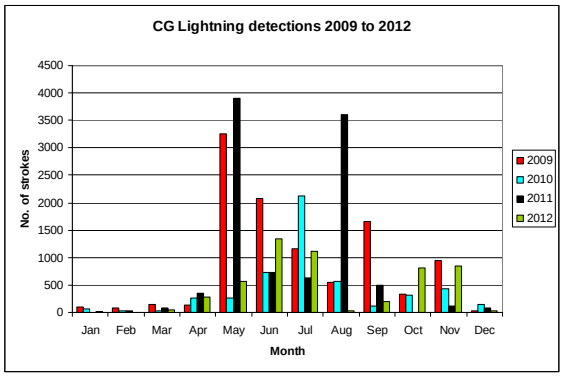

FIG. 6 Monthly distribution of CG lightning detections for study period.

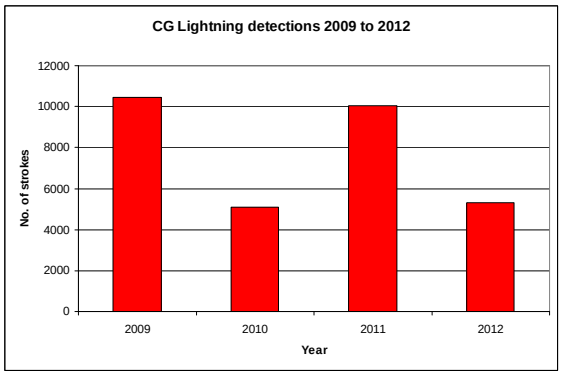

FIG. 7 Cloud to ground total strokes per year.

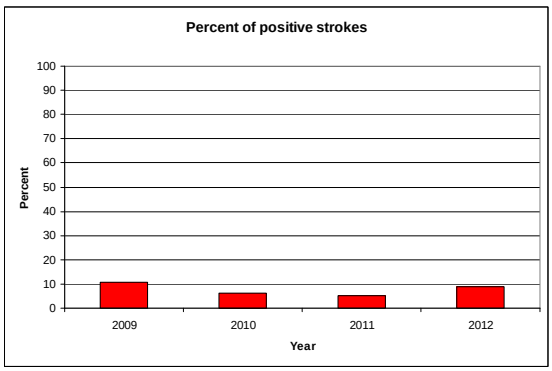

FIG. 8 Percent of positive strokes from annual value.

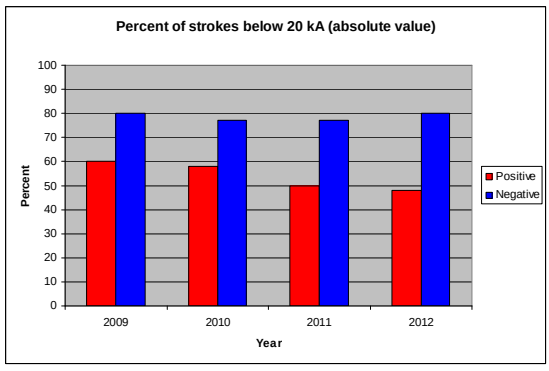

FIG. 9 Annual distribution of positive and negative strokes below 20 kA

IV. CONCLUSSIONS AND FUTURE WORK

In these four years of operation, nearly 31000 strokes have been detected and located in the Basque Country. 2009 and 2011 were very active years, with more that ten thousand detections each. On the contrary, 2010 and 2012 were less active years, counting a number of detections not higher than 5350 each year.

According to the latitudes in which the Basque Country is located, the peak of the lightning activity is associated to the warm months, from May to September. The moisture accumulated during the cold season and the beginning of warmer temperatures make May and June typical months for high lightning activity that usually concentrates on the south of the region, During those months insolation reach maximums, promoting thermal instability and typical warm season storms. From July on, the warmth accumulated by the sea contributes to more seaside thunderstorms and a higher electrical activity close to the coast.

Regarding the polarity of the strokes, the percent of positive strokes in each season ranges from 5% (2011) to a maximum of 10.7% (2009). In these four years, between 50% to 60% of the positive strokes detected in the Basque Country presented a peak current less that or equal to 20 kA, whereas nearly 80% of the negative strokes in all the four cases studied presented a peak current below this maximum.

According to the data retrieved by the network, the most intense positive CG stroke registered in this period had a peak current of 243 kA, and it occurred in the month of December of 2010. The most intense negative record corresponds to a stroke of -239 kA in November 2011.

In this work we have just presented preliminary results, further studies must be done in order to characterize geographical distribution, intra and inter annual variability, diurnal cycle and other relevant information including meteorological aspects and relations with weather types.

V. ACKNOWLEDGMENT

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