PRELIMINARY RESULTS FROM LIGHTNING DETECTION IN BASQUE COUNTRY.

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I. INTRODUCTION

In the last years, lightning detection has become a priority for severe weather monitoring in many national and regional weather services worldwide. The combination of data provided by different systems such as weather radars and Automatic Weather Stations (AWS) together with the great amount of data retrieved from Lightning Detection Networks (LDN) give an accurate picture of thunderstorm development and life cycle.

In the Basque Country a new regional network has been installed and calibrated, becoming operational in November 2008. This LDN provides accurate detections in most part of Basque Country Area. The system combines both the LF and VHF technologies and provides CG and IC lightning events detection and location. Thunderstorms over the Basque Country can now be detected and tracked using total lightning information, a new perspective with clear benefits in convective severe weather episodes.

In this work we present general characteristics of Basque Country Lighting Detection System (BCLDN), including some management aspects and strategies for operational use, finally some preliminary results from the first months of operational use are shown.

II. SYSTEM CONFIGURATION

BCLDN works with four sensors distributed over the region. These sensors combine Vaisala's Low Frequency (LF) and Very High Frequency (VHF) technologies, integrated in the LS8000 series from Vaisala. The whole sensor is formed up by the LF and VHF antennae, the rack with the GPS, the electronics and the operating system with algorithms that pre-process the events detected, a separate computer that acts as a central processor and another one integrating a database.

FIG. 1: Beluntza and Roitegi sites.

Each of the sensors integrates two subsystems. The LF subsystem provides, mainly, CG lightning information, allowing locations of CG impacts all along the Basque Country using the TOA (Time of Arrival) and DF (Direction Finding) techniques. VHF subsystem lets us have information about IC lightning. This is valuable for storm activation assessment and storm tracking. VHF detection is performed by using the interferometry technique. Each of the sensors integrates a GPS that allows accurate time stamping of every single event detected. This is essential for combining the data from the four sensors in the central processor. The two subsystems together provide total lightning information when the events detected by the sensors are correlated in the CP8000 system generating valid products (Vaisala, 2004). Data from the LF and VHF subsystems reach the CP8000 using different channels. These data are gathered real-time in the CP8000 with micro-second precision provided by the GPS in the sites. The CP8000 is also in charge of sending these valid products to a database and to remote computers for real-time visualization.

Placement for the sensors was established after having performed some preliminary studies (Vaisala, 2007), including the evaluation of the range of visibility, and electromagnetic noise aspects for different locations in order to guarantee appropriate coverage and to minimize noise presence. The Basque Country has a complicated orography and it is densely populated. These two restrictions make a lot of suitable sites unavailable for the installation of sensors, due to restrictions of electromagnetic noise when population is close to the site, or due to lack of power supply in isolated areas. Finally four places were selected along the Basque Country for setting up the network sensors (see FIG 2).

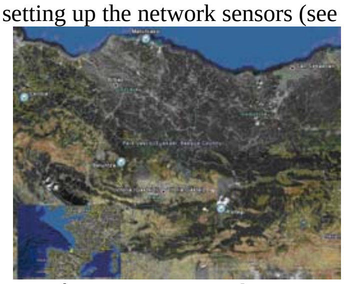

FIG. 2: Location of Basque Country and sensors on the BCLDN.

III. SYSTEM MANAGEMENT

System management is performed mainly using the software provided by the vendor. As mentioned before, the CP8000 receives the data from the sensors and applies different algorithms for final products generation. It also allows maintaining remotely the sensors by establishing telnet sessions used for checking and changing sensor parameters, in the case of the LF subsystem. Some programs, such as ApaControl and ApaConfig are used for setting up all the parameters necessary for the correct computation of the data retrieved from the sensors and that must be sent to the database or to the visualization programs. These parameters include gain and angle correction values, calculated during the calibration process.

General sensor status and VHF parameter settings are checked using Vaisala's Sensor Management Tool. Periodical site noise tests are performed with Vaisala's Data Analysis Module (DAM). Apart from the software provided by the manufacturer, remote control sessions are established with sensors or CP8000 using ssh or telnet clients. These sessions allow parameter checking for an on-line control of the sensors' operation and for having a better knowledge of the network's status.

Products obtained by the CP8000 by the combination of all the data retrieved from the four sensors, are stored in the APA5000 database. Apart from these CG products stored in the database, raw files and log files are generated daily in the CP8000 and stored in CDs. There are three different types of products generated every 10 minutes with LTS2005; discharges, cells and density pictures, final backup is performed monthly.

IV. PRELIMINARY RESULTS.

We have accomplished some actions for immediate use of BCLDN data according to a previous specific plan considering instruction aspects, definition of operational parameters and products for different purposes, backup and archiving strategies, calibration and quality aspects, the implementation of research and operational procedures.

Network calibration has been one of the main challenges. Vaisala defined the necessary procedures for the LF and the VHF subsystems. Conclusions point to the fact that the site errors remain acceptable and there is no significant noise affecting the LF subsystem, for the VHF subsystem, further calibration may imply some improvement in the overall performance of this subsystem.

Data quality control, at this preliminary stage is being carried out by comparison between the electrical activity detected by the LDN in different thunderstorms case and the data retrieved from a Dual Doppler weather radar available in the Basque Country (more details in Aranda J. et al 2006 and Gaztelumendi S. et al 2006a). For error characterization a confidence ellipse is available for every CG stroke detected. Not all the points within this area are equally likely, being the central point the most likely one (Vaisala, 2004).

For operational applications we need to assure the availability of adequate tools for generation of different products and for visualization, on a real time basis. For this purpose, as usual in the Basque Country Meteorology Agency (EUSKALMET), two different approaches are used, one based on vendor software capabilities and other based on our proper developments. BCLDN is used operationally for real time surveillance and storm monitoring in EUSKALMET. For this purpose we incorporate some different products in the intranet and in the so called "surveillance panel", a video wall available for real time products monitoring in Euskalmet offices (Gaztelumendi S. et al 2006b). On the other hand, we also use Vaisala's LTS2005 for real-time monitoring of IC events indicating thunderstorm development and CG impacts. As a preliminary procedure storms nowcasting are based on real time monitorization of BCLDN data, MSG, Radar and precipitation rates at same time on the "surveillance panel".

Off-line products and statistics are calculated based in archived products and retrieving information from the database and using Fault Analysis and Lightning Location System software (FALLS) for CG impacts and their errors representation over MapInfo's GIS layers. As an alternative we have developed a set of scripts that analyze the CG data contained in a certain area and represent them in a system such as Google Earth, based on KML files.

Data coming from BCLDN are used to perform detailed lightning analysis of past events. At present we are using vendor software capabilities for this purpose, DAM module for total lightning historic data analysis and FALLS module for in-depth cloud-to-ground lightning analysis. Most relevant cases, considering weather severity and electrical activity, are selected and studied. The final aim is to relate the lightning evolution characteristics to some local severe weather features.

Climatalogical studies are also considered, At present this task are related with some statistical calculus and monthly data in order to obtain best picture of lightning behaviour on our territory as possible (see FIG 3, FIG 4).

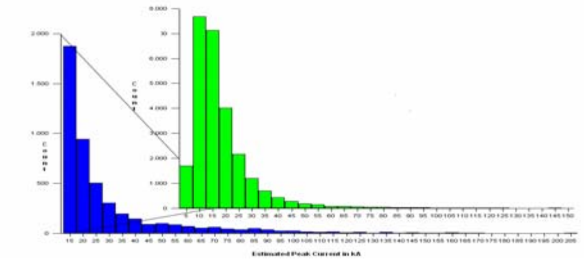

FIG. 3: Intensity distribution of the total counting of negative (green) and positive (blue) strokes detected from Nov 08 to Jul 09.

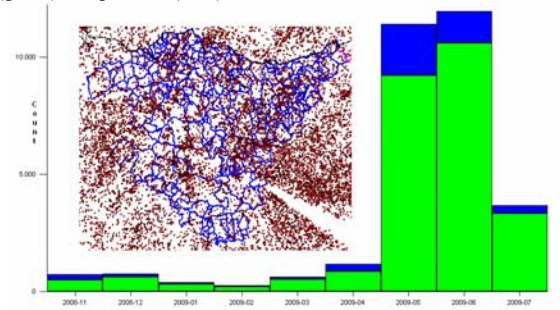

FIG. 4: Monthly negative (green) and positive (blue) strokes and whole strokes location for the period of operation.

VI. CONCLUSIONS

First results are promising showing the usefulness of BCLDN system, not only from the analisys and forensic studies point of view, but also for operational meteorology. Complementary with AWS, Radar and MSG data can be used to anticipate thunderstorm phase progression, alowing the identification of most severe cells within a thunderstorm.

Although four sensor locations are enough for covering the Basque Country whole territory and an overall good performance is obtained, the incorporation of new sensors needs to be considered in order to avoid bad locations problems at the eastern part of the territory, and for redundancy, always desirable on operational systems.

Due to the huge amount of information that the IC events imply, at this stage of the operation of the BCLDN, only the CG products are stored, this aspect is going to be revised and the IC events archived.

VII. AKNOWLEDGMENTS

Authors would like to thank our colleges from the Meteorology and Climatology Directorate and EUSKALMET. Especially we want to mention Dr. Martin Murphy, from Vaisala, for his invaluable collaboration.

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