A CASE STUDY OF CONVECTIVE SEVERE STORMS EPISODE IN BASQUE COUNTRY.

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I. INTRODUCTION

In this paper a study of a convective summer event in Basque Country is made. During this day heavy storms were produced all over the area, some single cells affect many points in Basque Country. In particular, Vitoria-Gasteiz city was affected by an extraordinary big size hail episode as a consequence of a rapidly evolving deep convection system that crosses the city. We analyzed different aspects of the environment characterization during this day, focusing on synoptic and mesoscale aspects and analysis of datasets coming from Automatic weather station network and different imagery products from Dual Doppler radar available in the area (see fig 1) and MSG.

During the afternoon of July 1st 2009, many shower storms are formed all over the area, due to heat accumulation all day long. Environment is characterized by a relatively high degree of thermal instability, large content of water vapor in surface and other factors that favor deep convective cells development, with a slowly eastwards displacement. As a consequence, at some places all over the Basque Country, heavy precipitations are registered. In the well-populated area of Vitoria-Gasteiz city hail size over 5 cm diameter causes many incidents and promotes important material losses. During this day in radar imagery can be seen a single active convective cell with large vertical extension and reflectivity values over 60 dBz.



FIG. 1: City of Vitoria-Gasteiz and Kapildui Radar location.

II. SYNOPTIC AND MESOSCALE ASPECTS.

The atmospheric environment is characterized by an undefined synoptic pattern or barometric swamp in the Iberian Peninsula that permits the appearance of a thermal low in the afternoon, due to thermal instability (figure 2). In lower layers is observed a warm air mass (20 °C in 850 hPa level, see figure 3) with high water vapour content in the air column, increasing its values in surface by a north light flux associated to the low thermal. In lower layers predominates warm and humid air with a high quantity of water vapour.

FIG.2 Sea level pressure (18:00 UTC 2009 July 1st)



FIG. 3 Geopotential and isotherm in the 850 hPa level (18:00 UTC 2009 July 1st).

An omega block pattern (see figure 4) is observed in medium and high troposphere, our region is located in the back of the ridge. Although the isohypses show a slight difluence, there is not dynamic instability. Air mass in 500 hPa level is not significantly cold (around -11 °C, see figure 4) although exists a moderate even high instability degree (TTI = 52 and LI = -3). Lift Index has values around the severe threshold established for the Basque Country area (LI \leq -3). Predominant west light flux in high levels slows down the storm translation. Strong wind shear is observed in the 0-6 km layer; upward fluxes in all levels of the troposphere favour the formation of storm cells or supercells than can produce severe weather.



FIG. 4 Geopotential and isotherm in the 500 hPa level (18:00 UTC 2009 July 1st).

In MSG HRV images sequence it can be seen the rapid development of the convective cell, beginning at 14:00 UTC very close to Vitoria-Gasteiz city (see fig 5 as example).



FIG. 5: MSG HRV product (zoom for Basque Country) at 15:15UTC.

In the Kapildui Radar imagery, available for the period of study, it can be observed the development of a convective cell at the west of Vitoria City; moving eastwards with 20 km per hour velocity (see fig 6 and fig 7 as examples). Hailstone shower over Vitoria City begins around 15:00 UTC and lasts 20 minutes, storm activity decays at 16:00 UTC.



FIG. 6: Cappi 2km for 15:02 UTC in 2009 July 1st.



FIG. 7: MAX for 15:02 UTC in 2009 July 1st.

This particular cell reaches a large vertical extension, with the cloud top reaching the tropopause. The largest vertical extension occurs around 14:50 UTC. The period of highest activity, lasts from 14:20 to 15:20 UTC, with maximum reflectivity values in the 60-65 dBz interval inside the 2-6 km layer. Below the 2 km level very high reflectivity values in 1-hour period are present.

III. SURFACE EFFECTS.

The analysed convective cell moves slow eastwards creating severe weather with intense showers; the most significant characteristic of the event is the size of the hail observed in the city of Vitoria-Gasteiz with diameters above 4 cm, even reaching 6-8 cm in some places (figure 8). These exceptional sizes are observed in the west part of the city, while in eastern neighbourhoods, 2 km far away, the hail doesn't reach those sizes. In city surrounding areas hail is not registered at all. During this event, strong wind gusts are registered, air temperature falls 8 degrees in 30 minutes (from 28 to 20 °C) and around 15 mm precipitation is accumulated in the area.



FIG. 8: Observed hailstone collected in Vitoria-Gasteiz during 1st July event.

The spectacular hailstone shower causes numerous material losses, estimated in millions of euros, broken windscreens and bodywork dents in a thousand of cars, broken blinds (see fig 9) and solar panels placed in building's roofs, trees, streetlights, etc. In the industrial area a lot of warehouse roofs are affected. Public and private

transport are affected during the hailstorm.



FIG. 9: Cars damages example.

IV. CONCLUSIONS

In a synoptic favourable environment for the formation of storms especially due to thermal instability, with instability indexes surpassing the threshold of severe weather established for Basque Country area, a deep convection phenomenon is generated during the afternoon of 1st July 2009, affecting Vitoria-Gasteiz city. A rapid evolving single-cell storm with large vertical extension, with cloud top reaching the tropopause, originates a severe weather episode. The hail registered in Vitoria-Gasteiz has diameters bigger than 4 cm, even 8 cm at some places, generating a lot of damages and problems in the city. In the Kapildui radar imagery is clearly observed the large extension of the convective cell and high radar reflectivity values during the critical moment when the hailstone storm is affecting some parts of the city. These reflectivity values are exceptional and have never been seen before, during Euskalmet operational surveillance activities at any place in Basque Country. This large hail storm knocked out windows, smashed roofs and dented thousands of automobiles.

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