A study of a tornado event in Basque Country: the 4th July 2018 case.

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Abstract

In this study we describe the occurrence of a tornado during the 4th July 2018 in the southern part of Basque Country (northeast Spain). It affects an unframed wooded area (the Legaire field in the Izki mountain range). The tornado touched in a beech forest causing significant damage, with hundreds of trees uprooted or cut by the wind. A total of 73 hectares (defined by a perimeter of 11 km, in an area of 2.5 km long and wide) up to 200 meters in some places. During this day, much of the Basque Country is affected by storms with heavy rains, hail and wind gusts, particularly the Alto Aresa and its capital Vitoria-Gasteiz, where urban floods and minor damages are produced.

In the work we focus on the study of meteorological situation during the event and on the atmospheric conditions for the occurrence of the tornado. We present an analysis of the general environment focusing on the relevant aspects that favor severe convection development, using different synoptic and mesoscale meteorological products and satellite images. Finally we include an evaluation of surface aspects and damages in the affected area.

Introduction

Tornado case in Europe (e.g. Llano et al. 2002, Tyeem 2003, Marshall 2008, Gaya 2005, 2010, Riesco 2015, Homar 2001, Bech 2007, Martin 1997, and particularly in Mediterranean area (Catalonia, Balearic Islands, and Andalusia) (e.g. Martin, Rivas 1977, Rivas Homar 2007, Bech 2007, Gaya 2005, 2010), there are very few, in fact none, in the Basque Country. The tornado touched down in a beech forest causing significant damage, with hundreds of trees uprooted or cut by the wind. A total of 73 hectares (defined by a perimeter of 11 km, in an area of 2.5 km long and wide) up to 200 meters in some places. During this day, much of the Basque Country is affected by storms with heavy rains, hail and wind gusts, particularly the Alto Aresa and its capital Vitoria-Gasteiz, where urban floods and minor damages are produced.

Results & Discussion

General environment

General environment is marked by high degree of dynamic and thermal instability. On the one hand, we are in the right side of the trough axis, on the other hand, cold air in medium and high levels generates a line of instability that moves from west to east during the time.

The synoptic situation is determined by a cold air bagging that moves from west to east by the northern peninsular third, generating marked instability. On the surface, the north component of the wind vector due to the stretching of the Azores anticyclone towards the Cantabrian and the formation of riverine trees to the east of the Iberian Peninsula (see figure 2).

Around noon instability indices and convection parameters indicate that the environmental conditions were favorable for tornadoes (e.g. Brooks, 2004, 2005, 2010, 2015, and particularly in Mediterranean area (Catalonia, Balearic Islands, and Andalusia) (e.g. 2005, 2010, 2015)).

Storm environment and Radar data

During the study day and partially from noon different storms affect and affect the Basque Country, leaving very strong showers (13.7 mm/10 minutes in Salvadore 29.4 mm/h in Añautxu) with hail of relevant size (3.4 cm in Arana area) and very strong wind gusts (72.3 km/h in Arana area). Thunderstorms with vertical development up to 12-13 km are very active with 8540 CG lightning strokes registered all over the area.

From 12:00 a storm core quickly begins to grow with a SW-NE trend, and it affects the area. At that point, tornado cores independently, first on the north and second on the center of the area. This one, four hours later, gets supercell characteristics and a front is seen in figure 6 (see fig. 6 and 7), with cloud top reaching the tropopause (13-14 km) (see fig. 6). Moreover, it can be seen in figure 7 where the radial wind images marks the cyclonic eddy solito-storm rotation structure. Note large relatively weak storm couplets evolve including smaller and a larger storm core. A plausible sign of tornadogenesis over the affected area.

In between 13:02 and 13:12 (see fig. 7) we can appreciate a kind of temporary collapse of the supercell probably also related with tornadogenesis.

In figure 8 a zoom on the area with some characteristics for 12:52 to 12:32 each 10 minutes. In the 13:02 we can see a kind of hook echo pattern showing the storm rotation and precipitation structure at west of the main affected area. During next 20 minutes some signature are compatible with a plausible tornado event moving to the east.

We must consider that complex orography in the area (sharp slope and funnel terrain configuration) favors the modification of the shear in low layers and the combination and potential of horizontal vorticity into vertical vorticity near surface promoting tornadogenesis.

Damages and impact analysis

The affected area (see fig 1 and 11) is located in the forest of Legaire in the Sierra de Entzia, which is a karst terrain, in a high area (between 500 and 1,000 meters of altitude), relatively flat and totally unpopulated. The forest is a fully mature beech forest with large specimens, most of the trees are 30 cm in diameter, with heights from 20 to 30 meters. The tornado (or tornades?) probably touched the ground at around 13.11 km path, although in first kilometers fallen trees are scarce and in small and scattered areas in the final 2.5-3.0 km/10 minutes. The trees are very abundant and in large areas where 72 hectares of mature woodland was almost completely uprooted (see figure 11). Being a karst area, the soil is not very abundant, but the trees and their roots uprooted the soil along with the calcium carbonate rocks where the soil settled (see fig. 12).

The most severely affected area is a two kilometers long wide that exceeds 200 meters at certain points. The trees are mostly specimens with 50-100 years, with diameters ranging from 35 cm in the smallest to the one meter in diameter and heights that generally range from 20 to 30 meters. The configuration of the fallen trees is, for the most part to the east, except on the north bank of the former clearing, which fall mostly to the west. The clearing has a Y-shape, especially in its western section, so the presence of two tornadoes cannot be ruled out. Tornado or tornadoes have a general movement from west to east. Among the affected trees, from time to time box with twist damages, broken branches at heights of 5-15 meters and with the wood totally splintered and burst are seen in the surroundings of the plausible tornado path. Some of the twisted trees trunks have widths greater than 30-40 cm. Since these are healthy specimens, the damages observed in the forest area are compatible with wind speeds greater than 180 km/h.

Therefore, given the characteristics of the damage, the trajectory, the directions of the trunks and uprooted trees probably one or two tornadoes reaches the surface in the affected area with wind gusts much greater than 180 km/h.

Conclusions and remarks

The studied case is the second documented tornado event in recent years and it is not related to the occurrence of fires in the study area, though there is no direct record of the occurrence of the tornado, the abundance and character of fallen trees (no different damage are observed) are compatible with the effect of a short lived F2 tornado or mesocyclone.

The Euskalmet Operational C-band Doppler Radar is quite near the affected area (20 km to the SW), it can’t see the smaller scales of resolution of operational products. In any case different radar products indicates the presence of different signatures compatible with a tornado-like mesocyclone, supercell-like structures, hook echoes in precipitation images and wind couplets in radial wind products.

Further work must be done in order to be a better as possible of the radar characteristics of this event and also an in deeper analysis of plausible trajectory. It is important to note that radar characteristics are tuned for general precipitation surveillance and that the different products of these radars are real time routine operational products.

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References

Gaya, S., 2005. Geopotential and horizontal wind speeds at 500 hPa and 850 hPa for 12:00 UTC on tornado day.
Gaya, S., 2011b. Geopotential and horizontal wind speeds at 500 hPa and 850 hPa for 12:00 UTC on tornado day.

Fig. 1. Basque Country location and affected area
Fig. 2. HRV MSG Image and metoffice analysis for 12:00 UTC on tornado day.
Fig. 3. 300hPa Geopotential height and wind speeds at 500 hPa and 850 hPa (from left to right)
Fig. 4. Some instability indices for 12:00 UTC (TILL, L_LCAPE and K from left to right)
Fig. 5. 12:00 UTC Surface wind.