KLAUS OVERVIEW AND COMPARISON WITH OTHER CASES AFFECTING BASQUE COUNTRY AREA

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I. INTRODUCTION

Strong extratropical cyclone (ETC) that forms in the North Atlantic often exhibits a period of very rapid strengthening known as explosive cyclogenesis. Those severe cyclonic storms can generate hurricane-force winds and when track across land, the results can be devastating. Usually strong ETC tracks over the north part of Europe, but in very few cases, can veer more to the south and affects south France and north Spain.

Explosive cyclogenesis generally happens when a surface cyclone deepens at a rate greater than 1hPa/hr over 24 hours. Is an extreme phenomena that consist on the deepening and intensification of a surface cyclone in a few hours period caused by its interaction with a perturbation in height consistent with baroclinic instability conditions. These phenomena can be characterized with the following criteria (Sanders and Gyakum 1980):

$$\Delta P \geq 24\left(sen\alpha / sen60\right)$$

with α the mean latitude along the low pressure trajectory. In our latitudes the pressure fall must be equal or superior to 19-20 hPa in 24 hours.

In this work we focus on those cases in which the Basque Country area is affected by extreme wind episodes during past years. Available wind data for the area are used, and synoptic situations considered in order to analyze different events. Finally we focus on Martin and Klaus cases making a comparison from Basque Country registered wind data.

II. WIND STORMS OVER BASQUE COUNTRY

The most severe wind storm in the Iberian Peninsula happened in the 1941 February 15th-16th, is in synoptic scale the most violent on XX century. This phenomena is originated, after the deepening of a strong depression in the northwest of Iberian Peninsula, with pressure central values lower than 960 mb. During this episode gusts over 200 km/h was registered in Basque Country area. At west, Santander city suffer worst fire in history.

In the last years the most singular episodes are Hortensia, Martin and Klaus cases:

October, 1984. Basque country is affected by the remains of Hortensia hurricane, that moves eastwards over the Cantabric Sea. Is a singular event that affects infrequently Basque Country. Cyclone are formed in the Caribbean Sea (hurricanes) moves towards higher latitudes and are absorbed by zonal circulation turn into deep extratropical cyclones (hurricane remains), Sometimes, the depressions get stronger by interaction with medium latitude perturbations. Previously, the cyclones had lost strength due to arriving colder waters.

1999 December 27th. A depression deepens in an extraordinary way in the Cantabric Sea due to an explosive cyclogenesis. Martin crosses Cantabric Sea from West to East (see FIG 1), originating intense southwest winds, with a later northwest rotation, when the maximum gusts surpassing 150-160 km/h in coastal places.

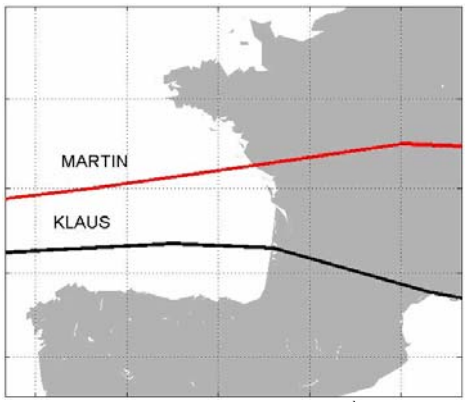

FIG. 1: Track of Martin (1999 December 27th) and Klaus (2009 January 24th).

During the 2009 January 23rd, 24th days the extratropical cyclone Klaus crosses the Cantabric Sea from West to East, affecting directly the Cantabric coast (see FIG 1, FIG 2 and FIG 3). In the Basque Country hurricane force gusts produce several material losses. The stronger winds begin the 23rd in the afternoon, west-southwest winds that intensifies at the end of the day, which specially blows in the interior areas and in mountainous interior areas due to the topography and wind direction. In exposed areas 120 km/h and 100 km/h in no-exposed areas are exceeded. The 24th day, when the cyclone arrives France, the wind begin to rotate towards the west-northwest in the early morning, blowing with special intensity in the coast and in mountainous areas in the north zone. The hurricane force gusts going on surpassing 150 km/h values in exposed zones. In no-exposed zones are about 100-120 km/h (see Gaztelumendi et al 2009 for more details).

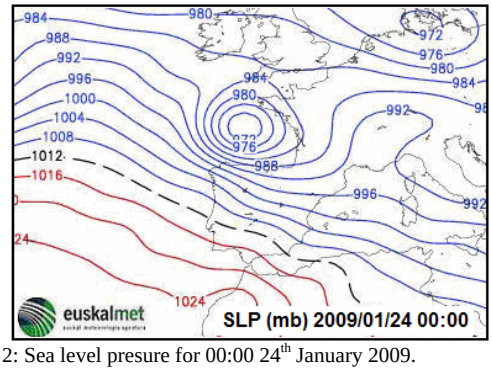

FIG. 2: Sea level presure for 00:00 24th January 2009.

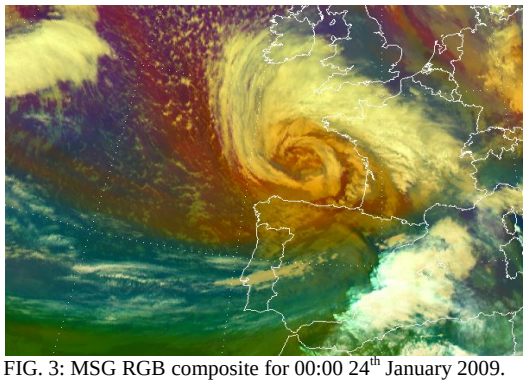

FIG. 3: MSG RGB composite for 00:00 24th January 2009.

III. KLAUS-MARTIN COMPARISON.

In Klaus and Martin episodes the necessary ingredients to produce an explosive cyclogenesis are present: strong horizontal temperature gradient, due to very different air masses meeting, strong vertical temperature gradient (instability), strong vertical shear and adequate jet stream structure. This phenomena is very frequent in North Atlantic in cold season. Normally, happen in higher latitudes than our, although in this two cases its unusual trajectory affect directly our territory.

The two events are quite similar, but we can mark some details regarding trajectory and pressure values. The Klaus trajectory is more southern arriving to the southwest of France, Martin arrives France in the south of Brittany region (see FIG 1). The pressure minimum that reach Martin cyclone is 970 mb, decreasing 23 mb in 24 hours. Klaus deepens 30 mb in 24 hours, reaching 963 mb.

In Basque Country an Automatic Weather Station Network owned by Basque Government is operational (see more details in Gaztelumendi et al 2003). This automatic network provides different meteorological measures at real time. Among others, provides wind data in different places all over the Country, each ten minutes. In Klaus and Martin events, maximum wind gusts present similar values. In southern stations the gusts are stronger that in the Klaus event (see table 1).

Stations		Maximum Gusts (km/h)	
		Martin 1999 December 27th	Klaus 2009 January 24th
South Area	Llodio	101	101
	Vitoria-Gasteiz	107	118
	Zaldiaran	127	132
	Iturrieta	94	123
	Kapildui	128	141
	Zambrana	101	126
	Navarrete	104	135
North-west Area	Pta. Galea	141	132 *
	Mungia	117	127
	Derio	106	103
	Oiz	177	158 *
	La Garbea	168	164
	Urkiola	99	96
	Barazar	125	114
	Orduña	126	154
North-east Area	Jaizkibel	167	158
	Zarautz	124	150
	Arrasate	91	105
	Bidania	123	115

TABLE I: Most significant data registered on Basque Country automatic stations (*broken during episode).

In some sense Martin is a similar event that Klaus not only considering his genesis and track but also analyzing registered maximum winds values over Basque Country area. Considering synoptic aspects Klaus is bit more violent than Martin, and at local scale very high wind gust was more generalized over the area in Klaus case.

III. RESULTS AND CONCLUSIONS

Usually, ordinary-generated deep Atlantic depressions cause gusts values superior to 120 km/h in exposed areas (specially in the mountain areas). But in this case, Klaus and Martin, explosive cyclogenesis generated very deep depressions, origin generalized values larger than 120 km/h and gust that exceeded widely the 150 km/h.

In the Klaus event in more than ten stations hurricane gust registers are observed, including no-exposed and exposed areas, in all stations gusts greater than 100 km/h are measured.

Although, in south part of Basque Country, Klaus measurements overcome Martin values due to the less deepness and the trajectory slight northern of Martin comparing with Klaus, in the north area not appreciable differences are found. In Martin case an important mesoscale factor is present, due to the relatively high temperatures before wind rotation. In Klaus case the synoptic factors are the most important.

Respect to injuries, during Martin episode 3 people died, during Klaus no injuries was produced in Basque Country area. Is important to consider that worst part of Klaus take place during night hours, meanwhile worst part of martin happens during afternoon on a Christmas day.

IV. AKNOWLEDGMENTS

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