

KLAUS OVER BASQUE COUNTRY: LOCAL CHARACTERISTICS AND EUSKALMET OPERATIONAL ASPECTS.

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I. INTRODUCTION

Winter storm Klaus was a mid-latitude cyclone that formed on January the 22nd of 2009 in the subtropical North Atlantic, west of the Azores Islands. The system moved from west to east over the Cantabric Sea with a trajectory parallel to the Cantabric coast, affecting Basque Country area on late 23rd early 24th January (see more details in Egaña J., 2009). In Basque country, wind gusts higher than 150 kilometers per hour were recorded in various locations across the region. A 200 kilometers per hour gust was recorded in a mountainous area in the interior. These are some of the strongest winds observed in Basque Country. On the other hand, waves as high as 21 meters were recorded in Matxitxako buoy (8 miles from Basque coast).

In this work, we present some aspects of this event, focusing on Basque Country local characteristics and operational aspects related with this severe weather episode. We present a detailed study based on data collected in more than 80 Automatic Weather Station (AWS) from the Basque Country AWS mesonet network (Gaztelumendi S. et al 2003) and other data available in the area including buoy data. We also present some available numerical models results (Gaztelumendi S. et al 2008, Egaña J. et al 2008, Gaztelumendi S. et al 2007) and Basque Meteorology Agency operational aspects related with forecast and severe weather warning issues during the episode. Finally, damages and some conclusions are pointed out.

II. LOCAL CHARACTERISTICS

Klaus track, Basque Country orographic characteristics and coastal configuration makes that first effects are produced in interior part of territory with SW winds followed by increasing W and NW winds affecting all the country and particularly coastal and high places (exposed areas). Mesoscale features shown that before the wind draft, W and SW affect the interior part of Basque Country, specially in Alava and mountainous areas, during the afternoon on day 23. After wind draft, during late night and morning on day 24 W and NW wind affects coastal areas and higher parts of Gipuzkoa and Bizkaia (see FIG 1).

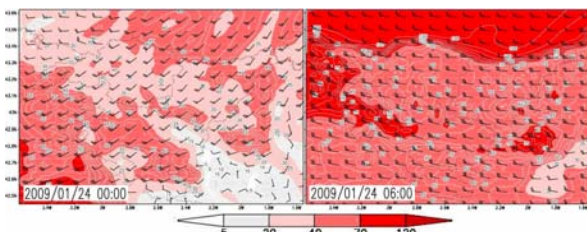


FIG. 1: Wind speed mesoscale forecast for Basque Country area for day 24 at 00:00 and 06:00 UTC.

Usually, ordinary-generated deep Atlantic depressions cause gusts values superior to 120 km/h in exposed areas (Egaña J. et al, 2006). But in this case, Klaus, explosive cyclogenesis generated very deep depression, causes generalized gust values larger than 120 km/h and wind gusts far exceeding 150 km/h in some places. Historic data were registered in wind time series at some AWS. In more than ten stations wind gust values over 120km/h are observed, including no-exposed and exposed areas (see table I), and gusts greater than 100 km/h are measured in nearly all stations along the Country. The wind gusts intensities registered are 50-70 km/h superior to the mean wind velocities measured. In Cerroja AWS, the highest wind speeds were recorded with wind speed over 130 km/h at 05:10 GMT and wind gusts over 200 km/h at 04:30 GMT (see FIG 2).

AWS	Max gust (km/h)	AWS	Max gust (km/h)
Cerroja	203,6	Pasaia Harbour	134,3
La Garbea	164,2	Treviño	132,3
Jaizkibel	157,7	Iurreta	131,4
Oiz	157,7	Ordizia	127
Bilbao Harbour	155,5	Mungia	126,7
Bermeo	154,4	Zambrana	126
Orduña	154,1	Zegama	118,9
Zarautz	150,5	Vitoria-Gasteiz	118,1
Arboleda	137,5	Bidania	115,2
Zaldiaran	136,2	Deusto	111,6

TABLE I: Most significant wind gust data registered on Basque Country Automatic Weather Stations Network

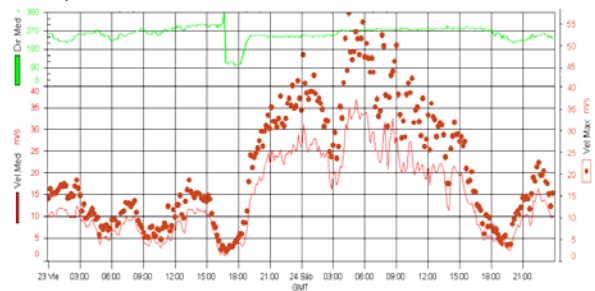


FIG. 2: Cerroja wind speed and direction during the episode.

Pressure data registered in the AWS network shows values dropped by more than 20 hPa in the space of only eight hours.

Klaus passage over Cantabric Sea also produces an exceptional worsening in the maritime conditions. The significant wave height surpasses the 8 meters in the early morning of the 24th, registering occasionally 13 m in the coast. At 8-mile from coast, in Matxitxako buoy, maximum wave heights superior to 20 m are registered (see FIG 3).

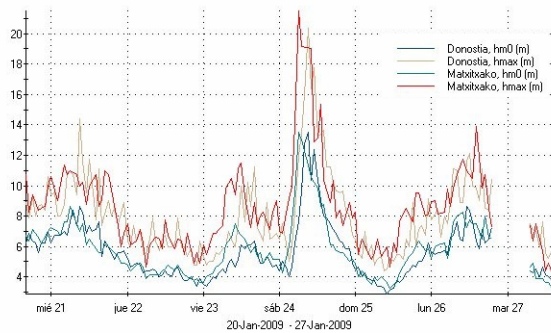


FIG. 3: The maximum and significant height evolution in Matxitxako and Donostia buoys (6-8 miles from coast).

III. EUSKALMET OPERATIONAL ASPECTS

On January 21st, EUSKALMET prognosis products shown the possible formation of a deep depression in the Atlantic west of the Azores Island on day 22nd, with a probable evolution and trajectory from west to east that can affect North Coast of Iberian Peninsula. Euskalmet mesoscalar numerical models and others available tools shown potential risk of local severe weather related with wind gust and swell. On January 22nd, morning, forecast products confirm explosive cyclogenesis phenomenon and shows depression trajectory parallel to Cantabric Coast. Mesoscale numerical available products shows probability of wind gust higher than 120 km/h for exposed areas and higher than 80 km/h for non-exposed areas in Basque Country, with significant wave high higher than 7 m. During the afternoon new data available, confirm the severe weather situation event, showing even high generalized wind gust that before. On 23rd morning forecast products for D and D+ 1 show that wind gust higher than 150 km/h and waves higher than 8 m can affect Basque Country.

On day 22nd severity and exceptionality of this event is clear for us, so especial reinforcement on severe weather usual procedure is applied. Routine operative staff is reinforced with additional surveillance and forecast personnel for 23rd afternoon and 24th night and morning, and special severe weather briefing is planned for 23rd early morning.

In those situations, it is important to consider that small perturbations at synoptical level, specially related with final track and final pressure values are critical in final local situation. Even at mesoscalar level, an increment in wind speed during frontal passage, especially in coastal areas, must be considered due to relevant thermal difference between air masses in the frontal system associated with the cyclone. Finally not special mesoscalar forcing was observed. Situation could have been even worse specially if final track would have been somewhat further south, or mesoscalar forcing finally would have increased locally wind values.

According with operational warnings procedure awareness reports was delivered for 23rd afternoon and 24th morning during previous days. On day 21st a yellow warning level ($V > 100 \text{ km/h}$ for exposed and $hs > 6 \text{ m}$). On 22nd with orange level ($V > 140 \text{ km/h}$ in non exposed and $V > 90 \text{ km/h}$ for rest of the areas, $hs > 8 \text{ m}$). On 23rd red level warning (first time since Basque Meteorology Agency is created on 2003) is established for coastal and higher areas due to wind gust higher than 150 km/h and for sea area due to significant waves higher than 8 m, and an orange one for any other part of Basque Country where wind gust higher than 100 km/h is highly probable.

IV. CONCLUSIONS

During days and hours before Klaus passage, special effort is made in order to explain risk and the unusual of situation. Basque Government applies civil protection plan and summon "crisis table" for coordination of actions among different agents (civil protection, police, firemen, municipalities, etc.) In EUSKALMET the pursuit of the situation was continuous, providing forecast, analysis and data reports for authorities and public before, during and after the episode.

Some preventive actions, never before applied, are considered, as population transfer far from the most affected areas. Some sea-side roads are closed, fishing fleet stay on harbor and even Bermeo fleet and other from minor ports goes to Bilbao during 23rd morning. Authorities make calls to population in order to stay at home during night and if possible not to take the car.

Finally thousands of trees were flattened all over the area, causing power outages and travel disruptions across all Basque Country and especially along the coast region. Uproot trees and flying objects cause many damages on properties and buildings. Over 200.000 population without electricity, because of damage to the overhead line network and power stations. Public transport canceled or disrupted with stoppages in Bilbao, Donostia and other cities. Airports temporarily closed and telecommunications networks disrupted.

Unless material losses are very important, no fatalities are produced. It is important to consider exceptional safety measures applied by authorities, to notice that this severe windstorm affects Basque Country mainly during night hours. Even, the fact that some newspapers and TV channels talk non-properly about deep low passage as if a hurricane was, makes that at the end people stay alert and very concern with potential risk of situation.

V. ACKNOWLEDGMENTS

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