ATMOSPHERIC CONDITIONS DURING SEVERE WAVE STORMS IN THE NORTH-WESTERN MEDITERRANEAN. GENERATION, EVOLUTION, DECAY AND IMPLICATIONS

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Abstract

In this paper, data from weather charts, meteorological stations and waverider buoys are used to analyse the atmospheric conditions during two severe wave storms in the Catalan coast. Through the analysis of the development of the two severe wave storms, some common characteristics have been identified. This allows the future forecast of similar occurrences and gains in understanding for improving numerical wave forecasts.

Keywords: wave storms, wind waves, wave modeling, wave climate

The considered severe wave storms [1] have been the two most energetic measured by the XIOM (Xarxa d'Instruments Oceanogràfics i Meteorològics) network since operational wave prediction started as a joint venture between UPC-SMC (Universitat Politècnica de Catalunya-Servei Meteorològic de Catalunya). The analysis has been done using mean sea level pressure charts from MetOffice, 500 hPa geopotencial and wind field results from the meteorological model GFS (Global Forecasting System) [2]. The observations come from waverider buoy in Tortosa Cape (50 m depth) and some meteorological stations from the XMET (Xarxa METeorològica) network deployed along the Catalan coast.

The first wave storm (November 9th and 17th 2001) resulted from the intense high pressure Atlantic center, moving toward the British Islands. This causes first, a strong entrance of N and NE air fluxes in the NW Mediterranean. Nevertheless, the waves had significant wave height (Hs) of 2.0 m from the NW, according to the wind direction influenced by the orographic effect of the Ebre's valley (NW-SE). The wave field direction deflects towards NE, reaching 3.0 m Hs (although the wind direction remains from the NW). Then the cold air contribution, especially in atmospheric high levels (500 hPa), develops a low in the Balearic Sea supported by the relatively warm autumn sea. By the 11th, the wave field takes an E direction and reaching 5.5 m Hs in the Ebre's Delta region. The quick movement of the low-pressure center turns the wind to NE and N (NW direction in Ebre's Delta). However, the wave field remains E towards with Hs higher than 3.0 m, but losing height and turning to NW in the Tortosa Cape. Cold air fluxes from the N feeds the low-pressure center, leading to an intense gradient for some days in the Genova Gulf. Later, the high-pressure center moves to the British Islands which induces NE and E air fluxes.

The wave field deflects to E with 5.9 m Hs (the highest recorded in 10 years). The low's feeding is then interrupted with a transversal position of the high level pressure. However, air fluxes from NE and E with large fetch persists. This sequence keeps a NW strong wind in the Ebre's Delta area, and NE and E moderate, although persistent winds during several days, in NW Mediterranean Sea. This situation ended when the high pressure center moved back to an oceanic position, stopping the eastern air fluxes on the Catalan coast.

The second wave storm (March 28th and April 13th 2002) was not a single storm but a sequence of 3:

1. The initial one, with a blocking anticyclone moving from the British Islands towards the Center of Europe. There was a strong wind flux (79.6 km/h in Porbou, 77.8 km/h in Barcelona, 65.5 km/h in Illa de Buda) from E with a long fetch which inducing eastern waves with 3.0 m Hs. This situation lasted for 4 days.

2. Undefined surface pressure configuration co-existing with a trough in the 500 hPa geopotencial level. This situation is prone to ciclogenesis in the Mediterranean area, which ends up by generating a subtropical low in the Alboran Sea. Wind and waves appear as a response to the low center movement towards Italy. A high variability in wind and in wave field can be observed. The new wave storm evolves from S-E mild winds to moderate NE that becomes NW in the Ebre's Delta area. The corresponding wave field reached 3.0 m Hs with E direction. The low dissipates in 4 days.

3. A high level cold air pool deepening generates a new surface low, affecting the whole NW Mediterranean littoral area during 3 days, leading waves coming from the E and reaching 3.0 m Hs.

After the analysis of both storms it is possible to assume that this type of configuration is favorable for triggering such events since both had a similar pattern (Fig.1). That the E winds are responsible for the highest energy seas on the Catalan coast, as could be expected. However the conditions of both severe wave storms are the result of synoptic situations that flow in this E direction on the NW Mediterranean. The common synoptic configuration features are:

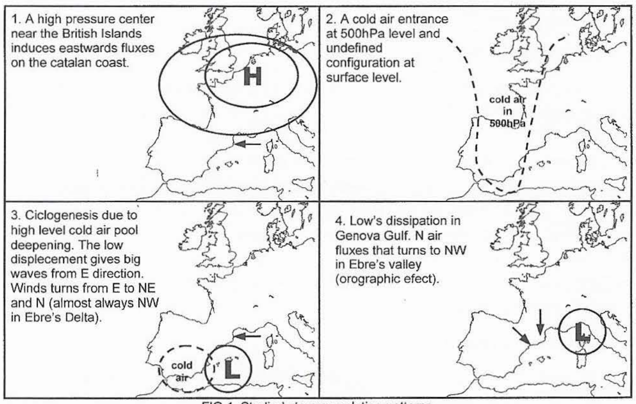

FIG 1. Studied storms evolution patterns

• The initial positioning of an intense high-pressure area on the British islands, leading to the NE and E air fluxes on the Catalan littoral.

• Mediterranean ciclogenesis due a to high level cold air pool deepening and the passage of the resulting low in front of catalan littoral. It generates E winds, except in Ebre's Delta area where the wind is coming from the NW due to orographic effects.

These results suggest a more detailed study of wave storm development on the Catalan coast is necessary. It is evident that they are associated to strong eastern events. However it is not well known which synoptic atmospheric situations support such wind fields. Moreover, it is necessary to analyze whether the most significant wave storms always follow the same pattern. In order to provide an index that allows an early warning for such situations with several days of anticipation, well outside the time resolution of operational wave models (WAM) [3].

References

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