CASE STUDY ON GENOA CYCLONE WITH MISTRAL 13-15 FEBRUARY 2005

Dunja Plačko-Vršnak, Nataša Strelec Mahović and Dunja Drvar

Meteorological and Hydrological Service, Grič 3, 10000 Zagreb, Croatia
E-mail : dplacko@cirus.dhz.hr

Abstract: This case study shows the occurrence of very strong Mistral spreading from France and Switzerland over the Western Mediterranean. Strong wind with gusts up to 85 knots persisted throughout the whole day on 14 February and is well documented in synop measurements. Mistral was caused by cyclogenesis in Genoa Bay triggered by the strong Northerly upper-level flow. In the beginning of the cyclogenesis the cold air flow was channelled through the Garone Valley between the Pyrenees and the Massif Central and through the Rhone Valley between the Massif Central and the Alps. Development of the cyclone is followed in the satellite images and by synoptic parameters. The jet streak played an important role in the process of cyclogenesis. The layer of Mistral is analyzed with the use of vertical cross sections (VCS) which show the origin, persistence and strenght of the wind. The VCS of the wind field parallel to the coast of France showed the low-level jet and the channelled effect of the Mistral. In the VCS perpendicularly to the Southern coast of France the flow over land and over the sea can be followed. During the whole period the maximum of the North-Westerly wind was just over the sea (near the coast).

Keywords: *Mistral, cyclogenesis, vertical cross section, jet streak*

1. INTRODUCTION

Mistral is a cold, northerly or north-westerly katabatic wind flowing into the Gulf of Lyon from the Southern coast of France. In the Gulf of Lyon, it is the strongest, with sustained winds often exceeding 40 kt, and gusts sometimes to 100 kt.

The effects of gale-force Mistral can extend into the Western and Central Mediterranean, blowing especially through the Strait of Boniface between the islands of Corsica and Sardinia and creating high sea conditions throughout the entire region.

Gale-force Mistral often develops when cyclogenesis occurs over the Gulf of Genoa with the passage of the 500 hPa trough through Eastern France. The Mediterranean Sea is a region with high frequency of cyclones - according to some authors, it is one of the most cyclogenetic regions in the world. Many of these cyclones are lee depressions, mesoscale and weak, but others are strong and cover a wide area.

For the Mistral to blow, it is also necessary to have a pressure gradient along the coast of France, with higher pressure in the Pyrenees or further to the east and lower pressure in the Apennines.

In this case study a strong wind persisted throughout the whole day on 14 February both on the coast as well on sea, which is well documented in synop measurements. The gusts were reaching 85 knots. (Fig. 1b).

2. THE CASE - SYNOPTIC SITUATION AND DEVELOPMENT OF MISTRAL

In the case studied here the synoptic development started in the Genoa Bay, triggered by the strong northerly upper-level flow. In the first phase of cyclogenesis, cold air blocking and flow splitting due to the Alps and the channeling between the Alps and Massif Central was important. Soon after, the second minimum appeared in the Adriatic Sea and than the centres moved to the south-east and deepend. (Fig. 1a).

High pressure gradient, across the Western Europe suggested very strong wind with gusts up to 85 knots – the occurrence of Mistral, which was spreading from France and Switzerland over the Western Mediterranean.

In the surface pressure field represented by 1000 hPa geopotential height, a strong gradient across the whole of Western Europe, caused by the difference in pressure between the low over Italy and Genoa Bay and a large high over the Atlantic was visible. (Fig. 2a)

At upper levels, parallel and very compact isolines of 500 hPa geopotential height (Fig. 2b), from the North across the British Isles and France to the Mediterranean show that the cold air flowed down towards the Mediterranean with high speed and indicate the position of the jet. The jet streak and surrounding sinking dry air play an important role in the cyclogenesis in the Mediterranean. The emerging cloud head appears in

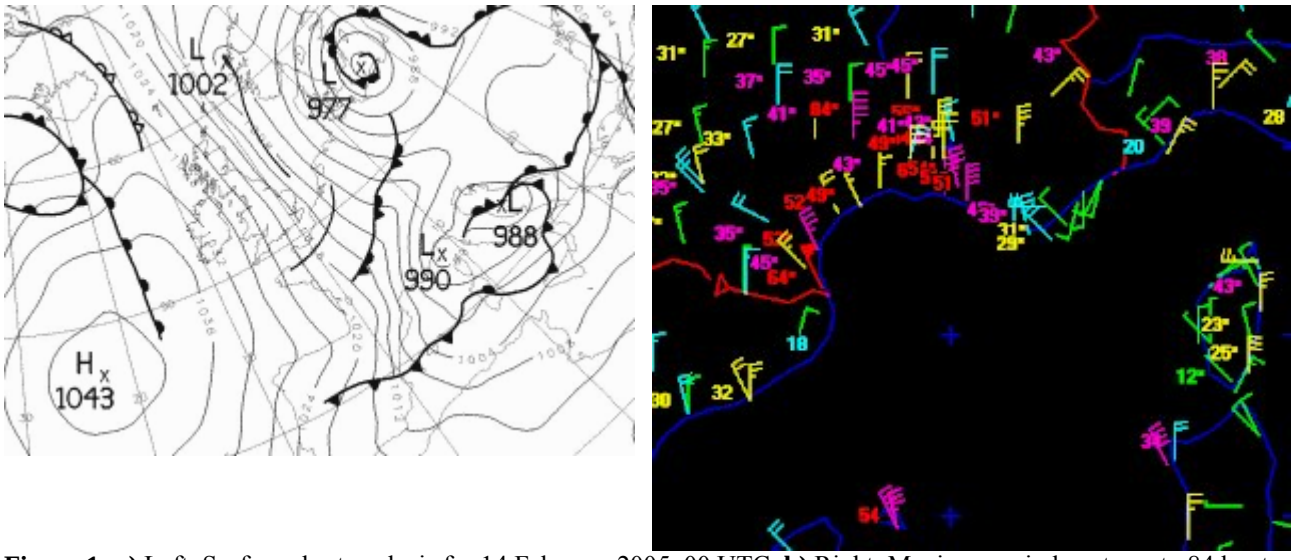

Figure 1: a) Left: Surface chart analysis for 14 February 2005, 00 UTC. **b)** Right: Maximum wind gusts up to 84 knots at the Southern coast of France on 14 February 2005, 12 UTC.

the left exit region of the jet streak which as can be seen in the Meteosat 8 IR 10.8 image on which the geopotenitial fields are overlayed. The surface and upper-level low are quite intensive during the mature phase of the cyclogenesis.

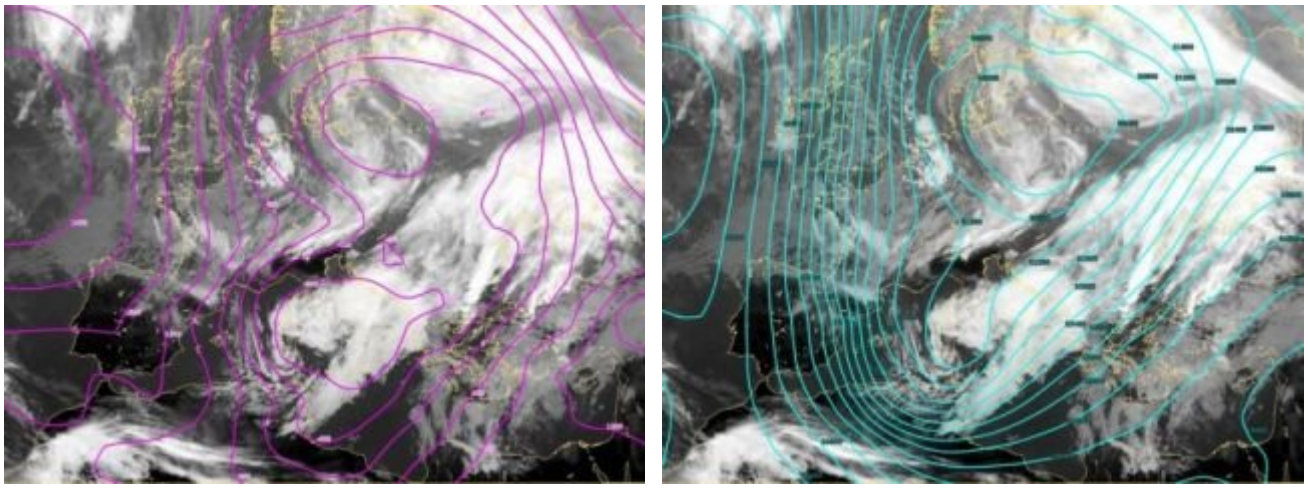

Figure 2: Meteosat 8 IR 10.8 image for 14 February 2005, 12 UTC overlayd with : **a)** Left: 1000 hPa Geopotential height, **b)** Right: 500 hPa Geopotential height.

3. VERTICAL CROSS SECTION

The mechanism of Mistral formation can be followed in the vertical cross sections parallel and perpendicular to the Southern coast of France. Mistral is characterized by the sinking of cold air generated over the mountains and then channelled through the Garone Valley between the Pyrenees and the Massif Central and through the Rhone Valley farther East between the Massif Central and the Alps. Overrunning of the cold air down to the lower levels playes an important role in the process of cyclogenesis.

Vertical cross section parallel to the Southern coast of France (Fig. 3 a) shows that the low level jet with speed of approximately 40 m/s (approximately 80 knots) appears between the Pyrenees and the Massif Central. Direction of the wind in the upper levels was changing from North-Westerly to Northerly. In the right part of cross section over Liger Sea the low-level jet is also present. Direction of the wind was North-Easterly due to the influence of the cyclone which formed in Genoa Bay.

Vertical cross section perpendicular to the Southern coast of France shows strong wind, almost through the whole layer, not only over the Mediterranean but also over inland of France. The strongest wind, the low-

level jet with speed up to 40 m/s, can be found over the sea, just near the coast (Fig. 3 b). The intrusion of cold and dry stratospheric air was channelled by Central Massif and the Alps.

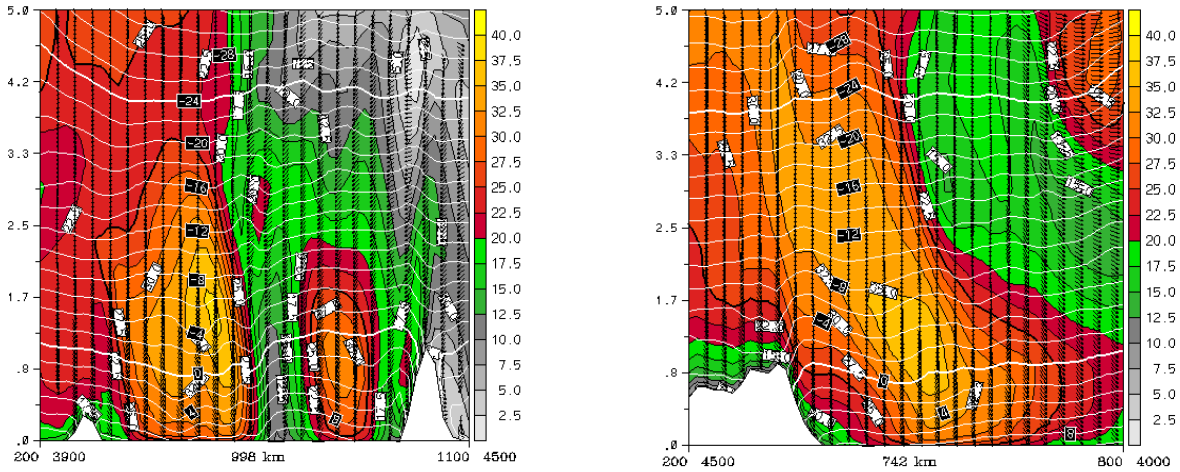

Figure 3: Vertical cross section of the ALADIN LACE model wind field for 14 February 2005, 06 UTC . **a)** Left: VCS parallel to the Southern coast of France, white lines: temperature, black arrows: horizontal wind, shaded areas : isotach. **b)** Right: VCS perpendicular to the Southern coast of France, white lines: temperature, black arrows: horizontal wind, shaded areas : isotach.

3. CONCLUSION

In the studied case the development of cyclone started in the Genoa Bay triggered by the strong Northerly upper-level flow. In the beginning of the cyclogenesis the flow of the cold air was channelled through the Garone Valley between the Pyrenees and the Massif Central and through the Rhone Valley between the Massif Central and the Alps. What makes this case special is the fact that with the cyclogenesis the very strong Mistral over West Mediterranean persisted almost throughout the whole period. At the same time very strong gradients in the pressure field were present which is also important for strong and long last Mistral.

The mechanism of Mistral was followed by means of vertical cross section. The VCS of wind field parallel and perpendicular to the coast of France showed origin, persistence and strength of Mistral.

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