Orographic Influence on Adriatic Vortex Generation

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Summary

The subject of this study is a cyclonic vortex genesis *in the wind field* over the Adriatic Sea. The vortex is an unbalanced – ageostrophic circulation system in which the center of vortex does not coincide with the center of low pressure. It is not formed by the lee-side effects as Alpine lee cyclogenesis, but the orographic influence appears through the special local winds – bora in the northern and jugo in the southern Adriatic. Both winds are relatively shallow and modified by the Dinaric Alps. Bora flow originates in the eastern side of Alps indicating an internal hydraulic mechanism across the mountain barrier. The jugo wind is associated with a cyclonic circulation in the Genoa bay entering the Adriatic area adds a southerly wind, but changing the direction to SE when approaching the coastal mountain barrier of Dinaric Alps. Mesoscale wind analysis emphasises a current through the valley in northern Italy (not the western side of Alps) toward the Genoa bay. An example of such a vortex generation is presented for the case of October 1999 during the MAP IOP 5.

Introduction

Routine meteorological observations over the Adriatic Sea are not sufficient for analysis in the meso-β and smaller scale ranges calling for special observation and modelling performance. We have focused here on the identification of meso-scale vortices in the surface wind field that can be diagnosed with high-resolution model field. Small-scale vortices were occasionally observed in the subjective analysis containing all available climatological stations along the Adriatic coast and islands.
The first objective analyses of these mesoscale vortices were presented by Ivančan-Picek (1998) using the scale separation technique. This investigation has shown that such a vortex is generated when jugo wind prevails in the southern and bora in the northern Adriatic Sea (Ivančan-Picek and Jurčec, 2003). Vortices can be found in this area along the frontal zones but they are of a very small size as short living features.

Synoptic characteristics and ALADIN/LACE mesoscale model forecasts

Here we present a vortex appearance in the mid-Adriatic observed during the MAP SOP on 5 October 1999, recognized by an eye and spiral cloud structure and simulated in the wind field over the Alpine area by the high resolution ALADIN/LACE predictions model. The vortex position is seen from the METEOSAT satellite images on 5 October, 12 UTC (Fig. 1) indicating spiral cloud band and a well-defined descending tongue of dry air as a dark band over the mid Adriatic.
Surface synoptic charts on 5 October 1999 show a typical blocking on the northern side of the Alps resulting in a

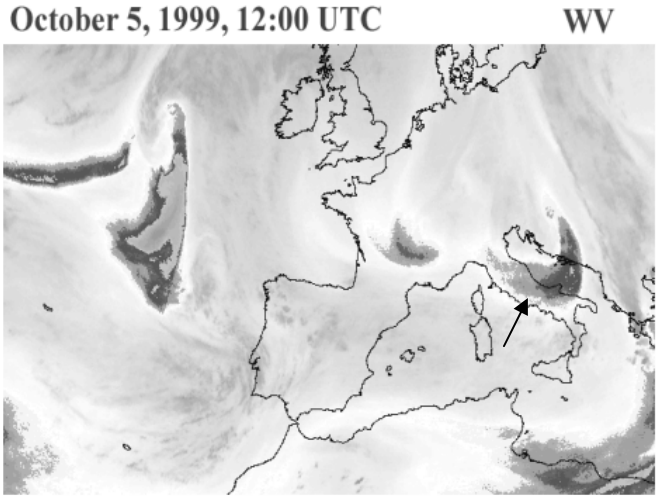

Figure 1: *METEOSAT satellite images for 5 October 1999, 12 UTC, water vapour (WV) image – the arrow marks dry intrusion (from MAP Data Centre).*

splitting flow and northerly currents on both sides of the Alps. The current on the eastern side of the Alps is a well known "bora flow" since the orographic effect at the mountains is controlling the flow upstream and the formation of a turbulent layer leads to decoupling of the descending bora air from the less disturbed air aloft, indicating an internal hydraulic mechanism for the bora (Smith, 1987).
At the same time the current on the western side of Alps is usually responsible for the cyclogenesis in the West Mediterranean leading to the S – SE jugo wind in the Adriatic Sea (Jurčec et al. 1996). However in our case during the genesis of Adriatic vortex this "western current" was not particularly strong and persistent. Instead the ALADIN model predicts a mesoscale current in the Alpine area through the valley transverse sections in the direction of the Genoa bay, not seen on synoptic scale charts. Fig.2 shows that this current turns cyclonically through the middle Italy toward the Adriatic. At the same time the bora appears at the northern Adriatic after 30 hours of prediction time. During the next 6 and 12 hours the Adriatic vortex is clearly generated in the wind field, and persists in the mid-Adriatic for the next 12 hours.

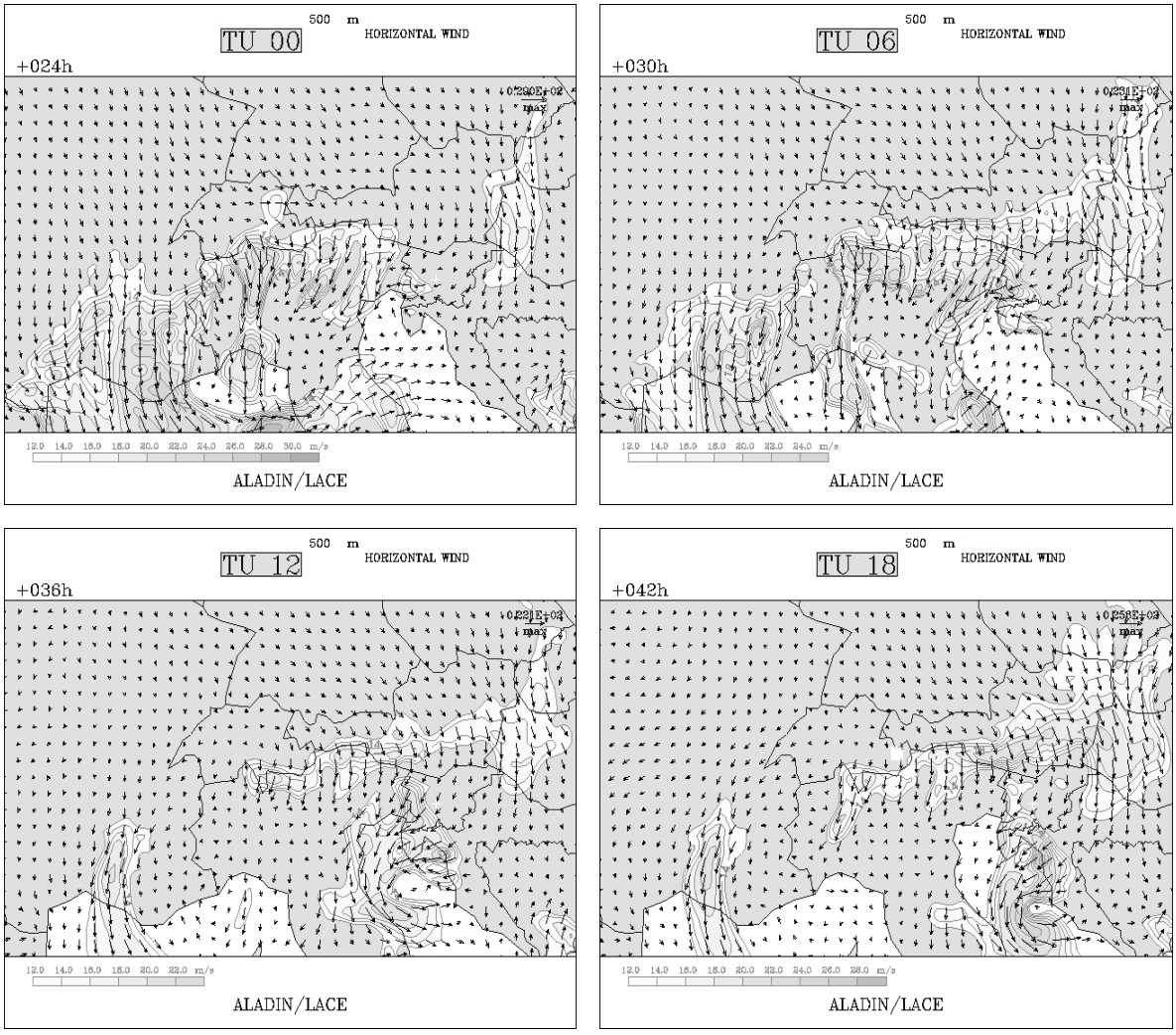

Figure 2: *Mesoscale 500 m wind forecast by ALADIN/LACE (MAP IOP 5) after 24, 30, 36 and 42 hours. Initial time, October 4, 1999, 00 UTC. Wind speeds above 12 m/s are shaded.*

The prediction of pressure field by the same model shows the low in the vortex center (Fig.3). This means that the vortex is in a geostrophic balance, which would contradict the results obtained by the objective analysis of mesoscale vortices (Ivančan-Picek and Jurčec, 2003; Gomis et al., 1990). The future studies should answer the question whether this adjustment is the result of modelling process or it is a realistic feature, at least in some cases and special circumstances.

Conclusion

The main conclusion in this work is that the orographic influence on vortex generation comes from the mountain effect on the wind field, particularly on intensity and duration of Adriatic local winds bora and jugo. This research stresses the importance of Alpine mesoscale wind field in which the flow confined to the valley transverse section toward the Genoa bay has a particular influence on the jugo wind.

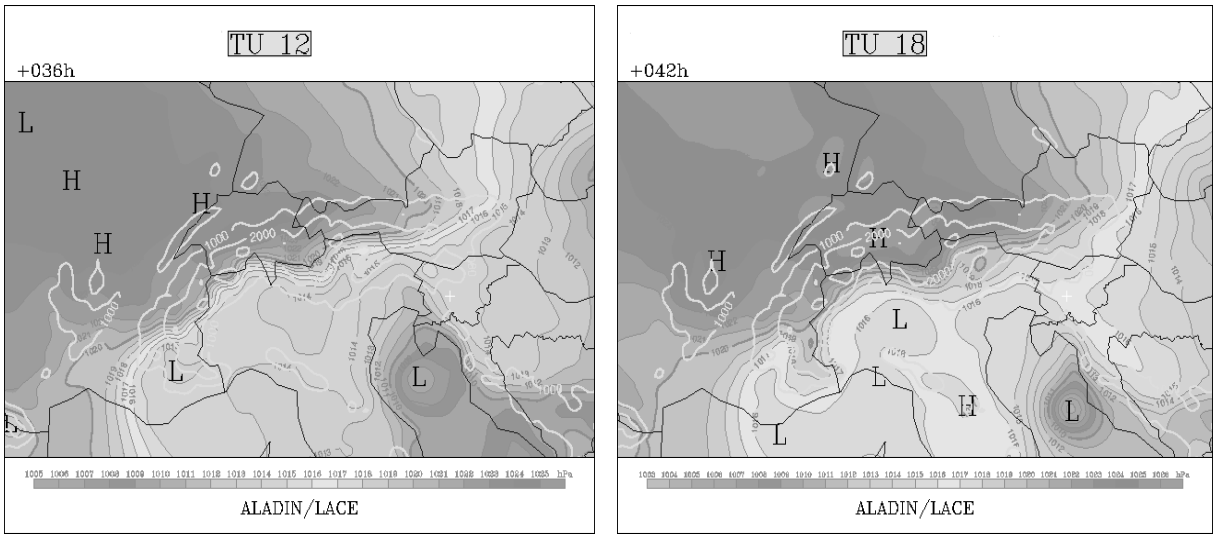

Figure 3: *Mesoscale sea level pressure forecasting by ALADIN/LACE (MAP IOP 5) after 36 and 42 hours. Initial time, October 4, 1999, 00 UTC. Isolines 1 hPa each.*

Acknowledgements:
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