ADRIATIC JUGO WIND DURING 2000 - 2004

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***Abstract**:* This study concerns severe Jugo wind cases during the last five years 2000 - 2004. Usually severe Jugo winds do not appear simultaneously in the larger area and frequently are found only locally. Generally, the causes of Jugo winds are the cyclonic activities to the west of the Adriatic area, but the maxima winds are related to the passage of deep frontal zones across the Adriatic Sea. This is the main reason for their local characteristics and short duration.

***Keywords** – severe Adriatic wind, Jugo*

1. INTRODUCTION

The most severe winds in the Adriatic Sea are the well known Bura and Jugo. Jugo is a southerly or southeasterly warm and humid wind customarily considered as scirocco wind. Jurčec et al. (1996) claim that Jugo is not generally scirocco, although jugo of gale force may have synoptic characterisics of scirocco. While Jugo is usually less severe than the Bura it could still reach locally more than 35 m/s and it could be very dangerous. Forecasting severe Jugo is of special importance since it induces high tides in the Adriatic. Since it is known that Jugo does not start so suddenly as the Bura, it is considered that it could be easier predicted. However, a dangerous condition during Jugo is in the local differences of wind speed and gusts depending on particular synoptic features connected with mesoscale cyclones and fronts (Ivančan-Picek and Jurčec, 2003).

2. CHARACTERISTICS OF JUGO

Fig.1 shows the eastern Adriatic coast and islands with 13 stations having hourly wind data considered in this paper during the 5 years period 2000 to 2004. There were 10 severe Jugo cases during this period (Table 1).

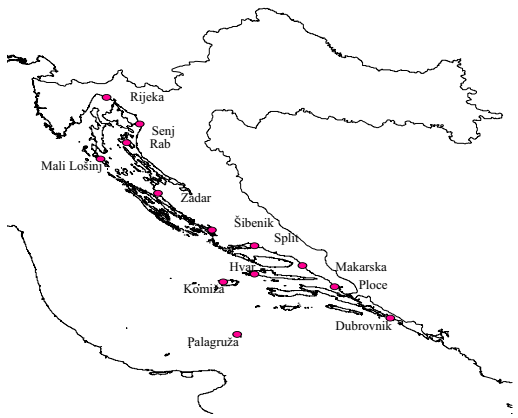

Figure 1. Eastern Adriatic coast with location of hourly wind data meteorological station.

Fig. 2 shows maximum hourly wind data for one particular day at all available stations. We did not have opportunity to compare this with earlier analyses, since this is the first task to analyse these 13 stations along the coast and islands, both by the climatological stations with classic anemographs and those with registrations. Jugo winds are best developed over open sea and islands, particularly along the Dalmatian coast. There were 277 days during considered period when weaker Jugo of 10.8 m/s (mean hourly wind speed) was registered at least at one station and 113 days with Jugo of 13.9 m/s. The analysis shows that severe Jugo is mainly associated with a deep low south of the Alps. The cyclones need not to pass the Adriatic, but strong east-west pressure gradient is sufficient to cause similar synoptic and mesoscale characteristics with rather different wind speed and gusts.

Table 1. Severe Jugo cases during 2000-2004.

Year	day	max. average hourly wind speed (m/s)	max. average 10 min. wind speed (m/s)	gust (m/s)	Station
2000	6 Nov.	19.7	20.5	42.7	Rab
2001	17 March	17.7	19.9	28.3	Makarska
2002	16 Nov.	19.2	19.6	28.3	Zadar
2003	20 Oct.	18.6	19.4	24.0	Palagruža
	1-2 Nov.	18.1	20.1	27.1	Dubrovnik
	28 Nov.	18.6	20.1	26.3	Dubrovnik
2004	22 Feb.	18.4	19.0	26.0	Palagruža
	7 March	19.8	20.7	28.	Palagruža
	4 May	18.0	20.0	25.6	Dubrovnik
	26 Dec.	23.9	25.8	33.1	Palagruža

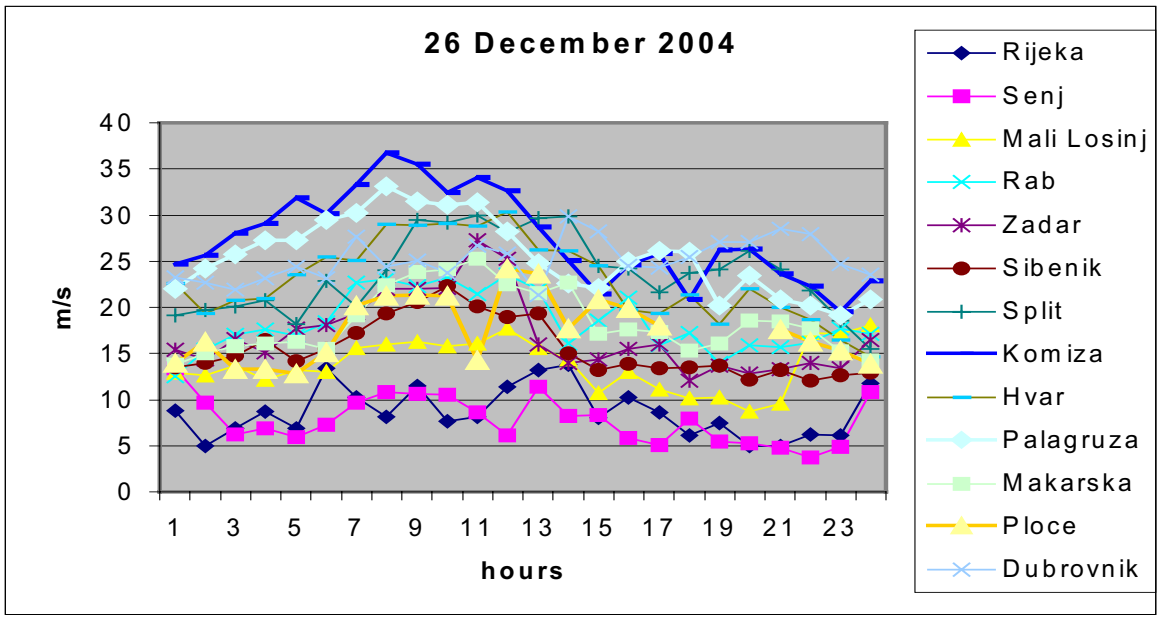

Figure 2. Daily course of maximum hourly wind speed values (m/s) for 26 December 2004 at all available stations mentioned in the Fig.1.

Fig.3 shows several examples of daily course of average hourly wind speeds, maxima gusts and wind direction for some severe Jugo events. In some cases wind speed can considerably increase in a relative short period of time (Fig.3a). With strong winds and gusts the direction is usually more variable (Fig.3c). A very strong Jugo in Rab in several of considered cases of our analysis was surprise to us, since we did not find it described in literature. The strongest Jugo with maxima gusts of 36.7 m/s in our analysis appeared in Komiža (Fig.3d). On this day around the noon time Zadar also indicates short term change of wind direction with maxima gusts (Fig.3b), but this was a temporal appearance of Bura which will be discussed next.

Fig. 4a represents the synoptic situation of 26 December 2004 with the fronts and cyclones frequently appearing during this time of year in the Adriatic, known as “Christmas cyclone”. For strong Jugo with high gusts cyclone need not be present in Adriatic, but strong surface cyclones on the west of Adriatic cause a strong west - east pressure gradient, which also explains a strong Jugo in Rab. Fig. 4b shows geopotential height at 300 hPa for 31 October 2003 with a deep upper level trough over western Europe which is a general characteristic at the upper level in all cases considered here.

Finally, the characteristics in the vertical direction in all cases considered here are demonstrated by the vertical time cross-section HRID shown in Fig.5. It is constructed from ALADIN/HR mesoscale

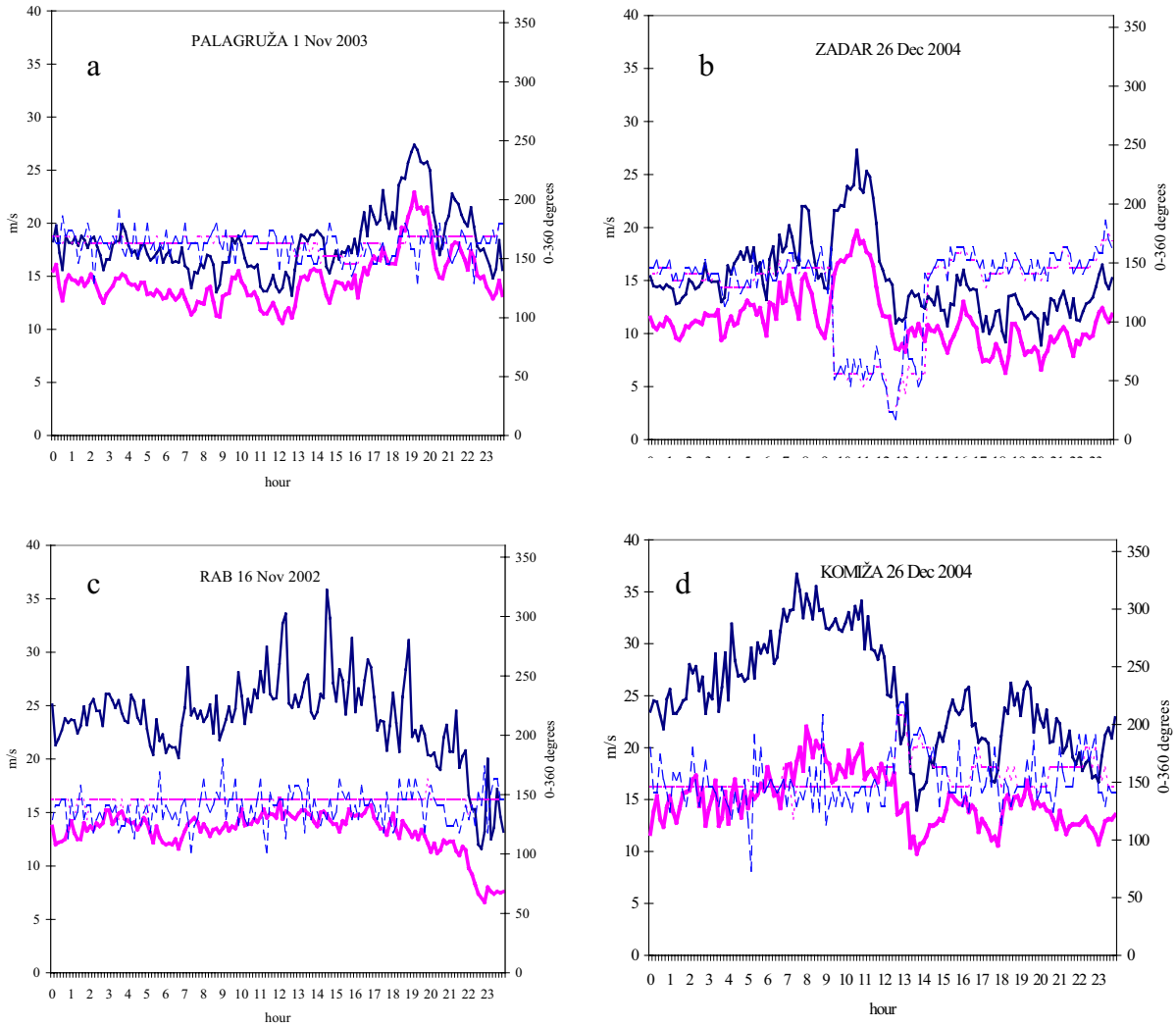

Figure 3. Wind measurement data for: a) Palagruža 1 November 2003; b) Zadar 26 December 2004; c) Rab 16 November 2002 and d) Komiža 26 December 2004. Blue solid lines are maximum hourly wind speed, pink solid lines are mean hourly wind speed (m/s) and dashed lines are wind direction (0 to 360 degrees).

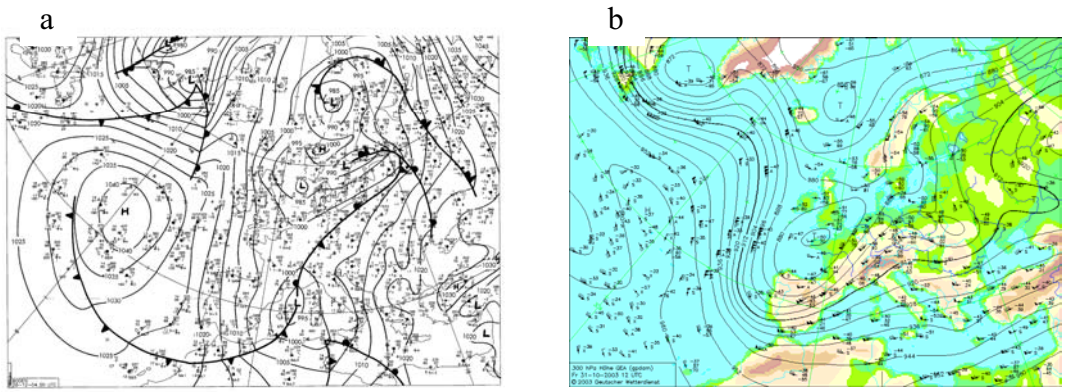

Figure 4. a) Mean sea level pressure analysis on 26 December 2004, 00 UTC; b) geopotential height at 300 hPa on 31 October 2003, 12 UTC.

model 48 hrs forecast with initial condition on 31 October 2003 during Jugo condition which lasted for the next 18 hours. The termination of Jugo is seen on meteogram following lowest sea level pressure, and drop of temperature and dew point. During Jugo there is a pronounced vertical wind shear from SE in the lowest 2 km to west - southwest winds on the eastern side of the upper level trough. Jugo termination is caused during the passage of the frontal zone expressed by the increase of the wind speed in the lower troposphere, increase of relative humidity and large equipotential temperature gradient throughout the lower troposphere.

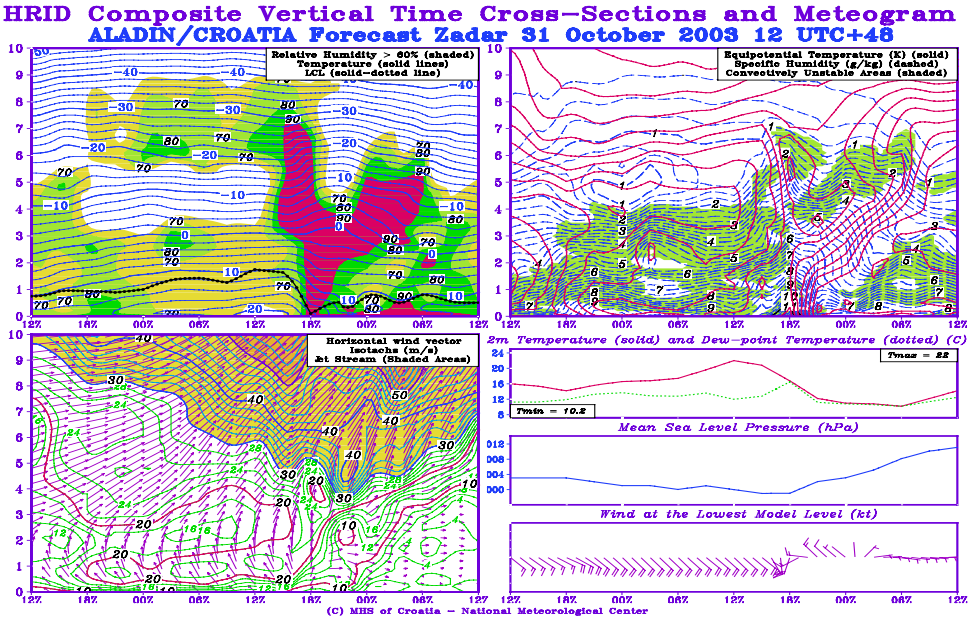

Figure 5. HRID composite vertical time cross-sections, ALADIN/HR forecast for Zadar, 31 October 2003, 12 UTC + 48. Top left – relative humidity >60% (shaded area), temperature (solid lines), LCL (dotted line). Top right – equipotential temperature (K) (solid), specific humidity (g/kg) (dashed), convective unstable areas (shaded). Down left – horizontal wind vectors and isotachs (m/s).

5. CONCLUSION

In conclusion, severe Jugo is a shallow weater phenomenon in the Adriatic Sea on the eastern side of deep upper level trough. Southerly wind in the lower tropospheric layer of about 2 km deep changes direction from S – SE, under the influence of coastal mountain ranges, to W – SW under the influence of upper tropospheric condition. The large local differences, besides topography, are largely influenced by surface cyclones and associated fronts which can cause a rapid change of wind direction and high gusts. This is the reason for very dangerous weather condition during Jugo, in spite of the fact that it intensifies gradually, contrary to Bura wind.

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