Analysis of convective indices over the northeastern Adriatic

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1. Introduction

The northeastern (NE) Adriatic represents the most convective area in Croatia, particularly the Istria, with more than 60% of convective days in the warm part of the years 2006-2009 (Mikuš et al. 2012). This area has a maximum number of convective days later in summer, mostly in August. However, the June-to-August variation in a number of selected convective days along the northeastern Croatian coastline was rather small. It also corresponds very well to the monthly thunder day distribution along the adjacent northern Italian Adriatic coast (Manzato, 2007). Mikuš et al. (2012) obtained that three dominant wind regimes on a large scale were observed in 82% of overall days with convective activity above NE Adriatic. They were from the SW (46%), NE (18%) and NW (18%) directions. Furthermore, the non-gradient pressure (NG) field (21%) is a dominant summer large-scale weather type with a maximum in July. The center of the cyclone (C, 21%), the eastern front sector of the cyclone (20%), the western back side of the cyclone (10%) and the front side of the trough (T, 12%) are the most common weather types in spring and late summer-autumn periods.

Thermally-induced flows, such as sea breeze (SB), are also very common phenomena along the Croatian coast (Babić et al. 2012) occurring on the average in 50 % of all summer days. Due to relatively large frequency of occurrence of both SB and cumulonimbus (Cb) clouds, their relationship was recently investigated. The results have revealed that in 51 % of daytime Cb occurrence, SB develops along the coast (Babić et al. 2012). However, the determination of theirs relationship is still based only on the surface measurements of two measuring sites, not allowing a deeper temporal and spatial analysis of their interaction (and characteristics of deep moist convection) over Istria.

2. Average characteristics of the convective indices for NE Adriatic region

Based on the dataset of convective days for the NE Adriatic region in Mikuš et al. (2012), we determined instability indices from the Udine (46.03°N, 13.18°E) radiosounding site which is the only radiosounding station in that part of the Adriatic coast. According to Groenemeijer and van Delden (2007) soundings within 100 km of the storm's event can satisfactory describe deep moist convective conditions. The mean values and standard deviations of the convective available potential energy (CAPE), convective inhibition (CIN), lifted index (LI), K-index (KI) and Bulk Richardson number (RiB) are presented in Table 1, showing some numerically convective characteristics of the dominant weather type and wind regime in NE Adriatic region.

Table 1. Mean values of convective available potential energy (*CAPE*, J/kg), convective inhibition (*CIN,* J/kg), Lifted index (*LI*, K), K-index (*KI*, K) and Bulk Richardson number (RiB) and their standard deviations for Udine radiosounding station. Abbreviations are: NG = non-gradient pressure field, C = cyclone, T = trough.

		$\overline{(CAPE)} \pm \sigma$	$\overline{(CIN)} \pm \sigma$	$\overline{(LI)} \pm \sigma$	$\overline{(RiB)} \pm \sigma$	$\overline{(KI)} \pm \sigma$
weather type	NG	428.7 ± 438.6	-71.5 ± 95.7	**-1.0** ± 2.3	77.7 ± 140.8	29.0 ± 4.9
	C	230.5 ± 351.2	-68.5 ± 65.9	0.8 ± 2.7	32.9 ± 97.4	27.2 ± 5.8
	T	**507.5** ± 575.1	-72.5 ± 59.7	-0.5 ± 3.2	**84.5** ± 202.4	29.8 ± 6.0
large-scale wind	SW	332.2 ± 490.6	-74.2 ± 67.8	0.4 ± 3.0	50.4 ± 236.3	28.8 ± 5.3
	NE	237.4 ± 327.3	-70.3 ± 63.1	-0.1 ± 2.1	31.8± 85.1	27.2 ± 6.4
	NW	**529.6** ± 629.0	-47.9 ± 100.5	**-0.2** ± 3.6	**146.8** ± 260.1	27.8 ± 8.3

The high mean values of CAPE and the KI and a negative LI correspond to the trough and non-gradient pressure field weather types that dominate during summer months. Lower values of the same indices are found for the cyclonic type due to its seasonal occurrence in spring and autumn. RiB has the lowest value for C weather type and much higher values for T and in days with the NG weather type. These large values due to lack of shear, suggest a high potential for ordinary or multicell storm development. Values of RiB being lower than 45 for the T weather type and for the SW flow regime, suggest conditions favorable for supercell development. The NW wind regime is followed by the highest atmospheric instability (smallest CIN and highest CAPE, LI and RiB) and the NE wind regime is accompanied by the lowest atmospheric instability.

3. Results and discussion of numerical simulations

In order to get insight into the spatial and temporal distribution of convective parameters we selected and simulated three chosen cases from the dataset of Babić et al. (2012) that satisfy simultaneous occurrence of SB and daytime Cb above Istria. An each selected case also contains an interaction of SB with one of the dominant types of large-scale wind: NE, SW and NW above Istria. The simulations were performed by the WRF-ARW mesoscale model. To evaluate the influence of the SB over the Istria on the moist convection processes and convective indices, we performed an additional numerical sensitivity test for the case with NE large-scale wind without microphysics scheme (called A0 case).

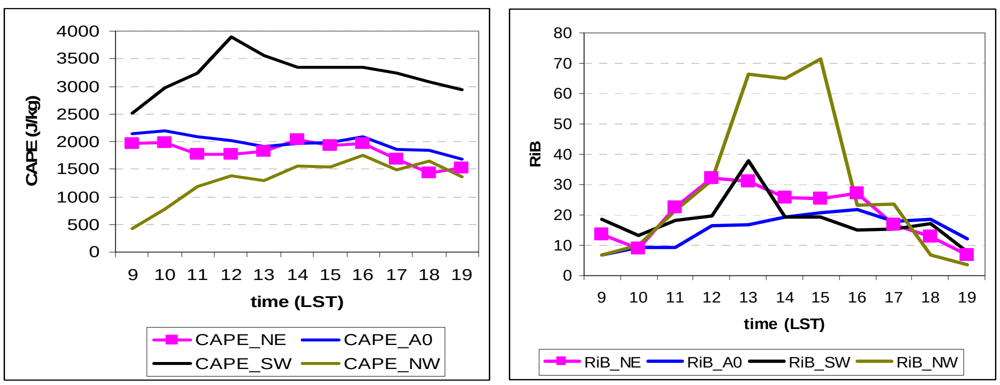

Figure 1. Temporal evolution of max *CAPE* (J/kg) and max RiB above Istria from three selected simulated WRF cases covering dominant types of large-scale wind (SW, NE, NW).

Results (Fig. 1) showed only partial similarities with average convective indices in Udine. Opposite to the “climatological” relationship between CAPE and wind regimes, the most prominent CAPE values are for the superposition of SW large-scale and the SB flow. They are however accompanied by the relative small RiB (< 45), Fig. 1. As we expected, the NW case has the largest RiB (> 60) that coincides with values in Table 1.

References

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