THE IMPACT OF MODEL RESOLUTION ON SIMULATED DISTRIBUTION OF BURA

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Abstract: Nonhydrostatic mesoscale model MM5 was used in order to model a spatial distribution of bura wind in Maslenica bridge region (Croatia). A 3 km domain and a 1 km domain nested in a 3 km horizontal domain were used. Both runs were initialized from the same NWP ALADIN/Hr runs. Spatial differences between the model setups are addresed. The main characteristics of wind field was well indicated on both domains. It is found that 1 km domain much better reproduces local characteristics of wind field than 3 km domain.

Keywords *– MM5, bura wind, NWP*

1. INTRODUCTION

Spatial variability is an important characteristic of bura wind, which occurs on meso and local scale. The mesoscale variability is connected with the bura dependence on the upstream atmospheric conditions (Vučetić, 1985) and for local variability orography plays an important role (Jurčec and Brzović, 1995).
Two locations on the eastern Adriatic coast are well known for their very severe bura events. Those are Senj and Maslenica bridge. Senj is situated in the northern, lower part of Velebit mountain, beneath Vratnik pass and Maslenica bridge is situated beneath the southern, higher part of Velebit mountain. Numerous studies were employed with Senj (e.g. Bajić 1989, Belušić et al. 2004), and since new bridge has been built over Maslenica gorge this location started to occupy attention (e.g. Ivatek-Šahdan and Tudor 2004).
Since bura varies very much from site to site, a good representation of local bura characteristic is very important. Jurčec and Brzović (1995), in their analysis of bura events along the Adriatic cost, concluded

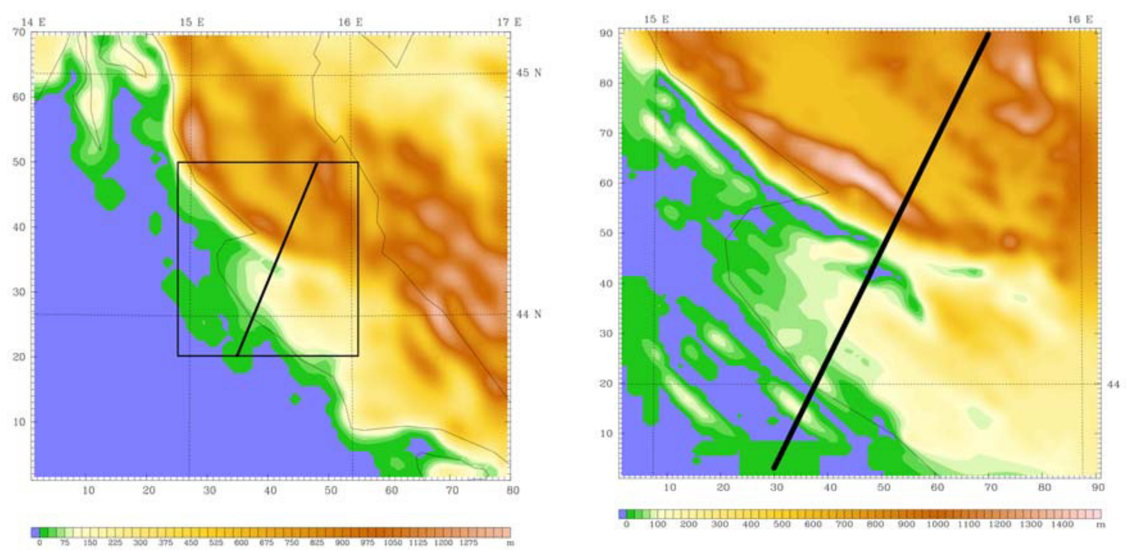

Figure 1. Domains with 3 km (left) and 1 km (right) resolution. The coast line as resolved by the model at 10 m. Square inside 3 km domain represents Maslenica bridge region which is analysed. The diagonal line represents vertical cross section.

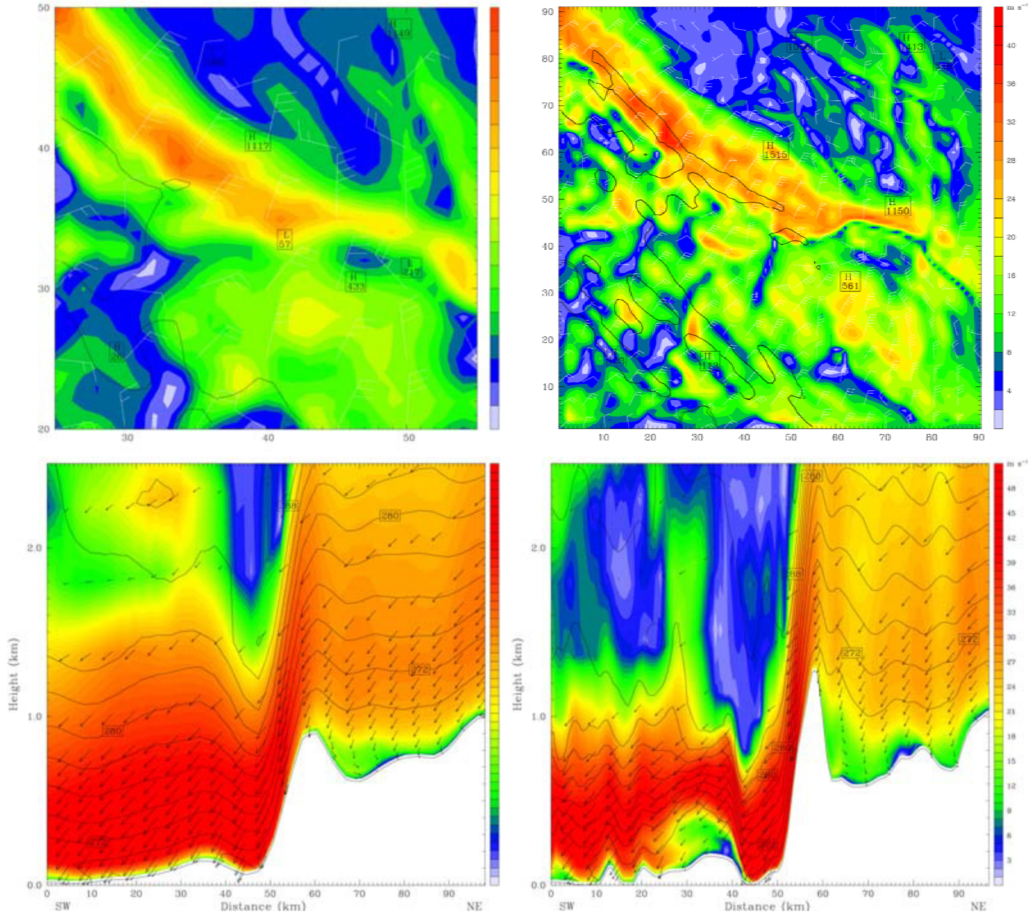

Figure 2. Horizontal wind fields (top) on D3 (left) and D1 (right) and vertical wind cross section (bottom) on D1 (left) and D3 (right) for 23 December 2003 at 22 UTC.

that a fine mesh model with a realistic orography and a high level of sophistication for moist, turbulent and non-hydrostatic processes is necessary to predict the onset, duration and strength of bura. On the other hand a very high-resolution dynamical adaptation of the wind field with the operational, hydrostatic ALADIN model (Ivatek-Šahdan and Tudor, 2004) have shown a very good predictability of the occurrence, strength and spatial variability of the bura wind.

The aim of this study is to compare MM5 model capability to predict spatial variability of bura on 1 km and 3 km resolution. The domains include Maslenica Bridge and its surroundings.

2. MODEL DESCRIPTION

The PSU/NCAR MM5V3 (Grell et al 1995) is a community, non-hydrostatic, fully compressible limited area model. It employs terrain following pressure based vertical coordinate. In this study eta PBL parameterization based on Mellor-Yamada level 2.5 scheme was employed. No parameterization of convection was used. The surface energy budgets were computed using a 5 layer soil model. The Reisner graupel explicit cloud microphysical scheme and Rapid Radiative Transfer Model for shortwave and longwave radiation calculation were used. Upper non-reflecting radiative boundary condition was employed which allows disturbances to leave the computational domain without being reflected from the top.

The model was run in two different setups that differed in the usage of grid nesting only. In the first setup two two-way nested grids were employed with 3 km and 1 km horizontal resolution. The second setup

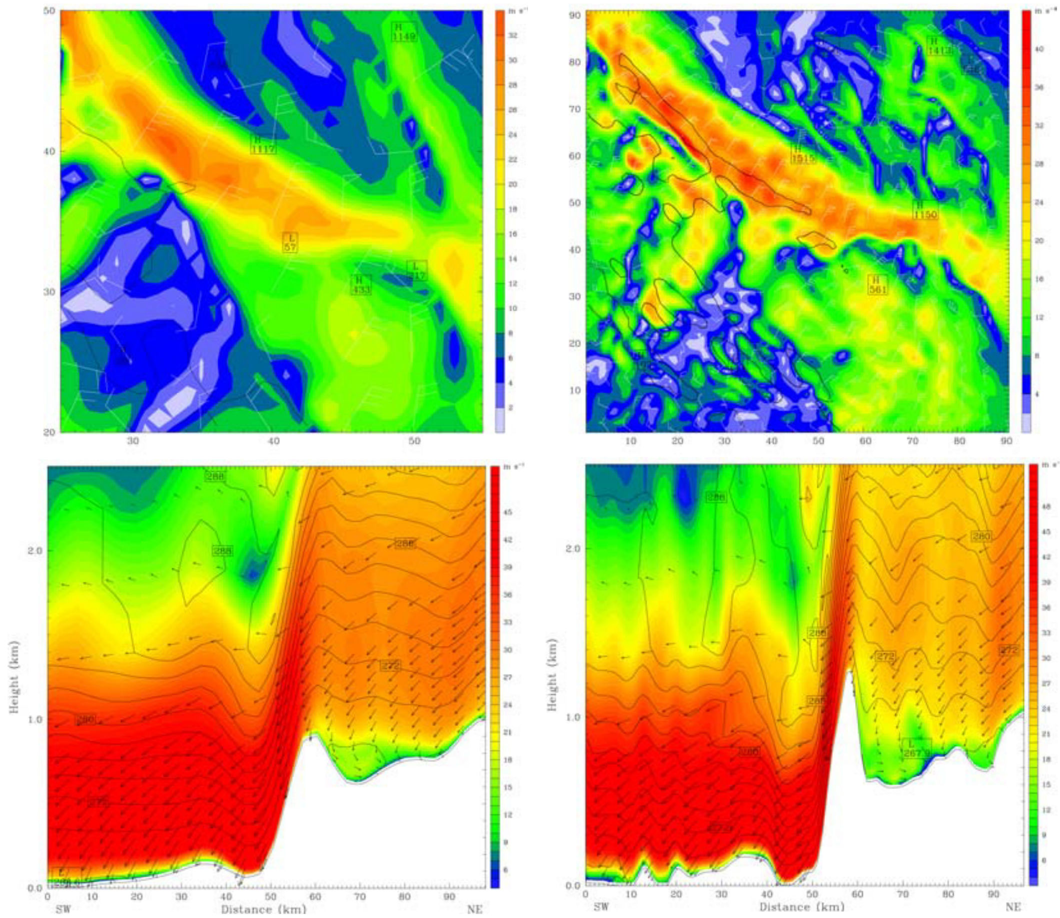

Figure 3. Horizontal wind fields (top) on D3 (left) and D1 (right) and vertical wind cross section (bottom) on D3 (left) and D1 (right) for 24 December 2003 at 04 UTC.

used a single 3 km grid. Both setups were run with the same physical options. Both setups used 30 vertical levels with the model top at 100 hPa. The distribution of vertical levels provided greatest resolution in the PBL. Coarse grid integration time step was 9 s.

The model was initialized using ALADIN/HR operational forecasts and the lateral boundary conditions were updated every 1 h. The horizontal resolution of the ALADIN/HR was 8 km. Detailed explanation of ALADIN/HR operational setup used at the Meteorological and Hydrological Service of Croatia are given by Ivatek-Šahdan and Tudor (2004). All forecasts started at 00 UTC, and lasted for 48 hours.

We have run several bura cases for winter season 2003-2004. Two most interesting cases, 23 and 24 December 2003, are shown.here.

3. RESULTS AND DISCUSION

Representations of terrain, with 3 km (D3) and 1 km (D1) domains are shown in Figure 1. Orography is more accurately represented on D1; mountain peaks are higher and shapes of coastline and islands are more apparent.

Surface wind fields on D3 and D1 are shown in Figures 2 and 3. Areas of wind maximum are just beneath mountain slopes and as the distance from mountain becomes larger the wind speed suddenly becomes weaker. Those characteristics of wind flow are well indicated on both domains.

Local representation of wind flow is better indicated on D1, whereas on D3 wind field is smoothed without significant local extremes. A great local variability is expected on that region as the measurements (data not shown) during the highway construction have shown.

The vertical cross sections of horizontal wind speeds and directions for both domains are shown in Figures 2 and 3. In the lee of the mountain in middle troposphere wave breaking occures which reflects as the compression iseontropes at lower highs (Figs 2 and 3). This causes acceleration of the wind accros the mountain slope, which is more pronounced on D1.
The layer of the maximum wind speed on D1 is thinner and closer to the mountain slope. Due to orografical obstacles wind speed near the surface below the mountain decelerate significantly. That effect is, because of better orographical representation, more noticeable on D1 then on D3. That is the most evident on the 23 December 2003 at 22 UTC (Fig 2 bottom), when orographically induced lifting of bura layer from the surface and a wake in the surface flow are obvious.

4. CONCLUSIONS

More representative orography is given with D1. Both domains show general agreement in the main characteristics of bura wind field. D1 much better reproduces local characteristics of wind field (on scale more or equal to 1 km) and it is able to reproduce effects that are not apparent on D3. Wind fields characteristics on micro locations (less than 1 km) such as sides of Maslenica Bridge which have different wind regime (Bajić, 2003), could not be recognized nor with D1.

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