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The influence of WRF parameterisation schemes on high resolution simulations over Central Greece

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1. INTRODUCTION

The region of Thessaly in central Greece is one of the main areas of agricultural production in Greece. Climate change and the continued increase in water needs, for both urban and agricultural use, have largely exhausted water supplies. For this reason the project DAPHNE aims at tackling the problem of agricultural drought in Thessaly by means of weather modification through the development of the necessary tools to support the application of a rainfall enhancement program . In recent years, the development of new sophisticated atmospheric models, in conjunction with modern instruments for recording and measuring atmospheric and cloud physics data have increased the interest for weather modification, and particularly for precipitation enhancement projects (Silverman 2003).

In the present study an attempt is made to estimate the ability of the WRF model (WRF-ARW ver3.5.1) to reproduce selected days with high convective activity (suitable for rain enhancement) during the year 2010.

2. DATA AND METHODOLOGY

The nonhydrostatic Weather Research and Forecasting model with the Advanced Research dynamic solver (WRF-ARW Version 3.5.1; Skamarock et al. 2008, Wang et al. 2014) was utilized in the numerical experiments. WRF is integrated in three domains covering Europe, Eastern Mediterranean and Central-Northern Greece using telescoping nesting with grid spacing of 15km , 5km and 1km, respectively (Fig 1). By alternating microphysics (Ferrier-ETA, WSM6, Goddard), boundary layer (YSU, MYJ) and cumulus convection (Kain-Fritsch, BMJ) schemes, a set of twelve model setups is obtained (Table 1). The cases examined belong to the transitional and warm period (June to September) of the year 2010 including days with thunderstorm activity. Model results are evaluated against all available surface observations and radar products, taking into account the spatial characteristics and intensity of the storms.

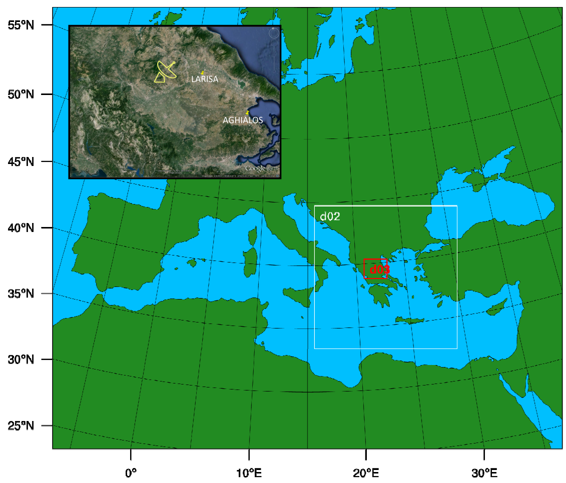

Figure 1. *Model domain setup used by WRF-ARW in the numerical experiments. (inline picture presents innermost domain topography and radar position).*

The radar used is a C-Band (5cm) radar located at Liopraso (within domain d03 (39.674 N, 21.837 E) interfaced to TITAN (Thunderstorm Identification, Tracking, Analysis, and Nowcasting) (Dixon and Wiener, 1993) for data analysis.

Table 1. Model Setups used in the study

ETA-KF-YSU	WSM6-KF-YSU	GOD-KF-YSU
ETA-KF-MYJ	WSM6-KF-MYJ	GOD-KF-MYJ
ETA-BMJ-YSU	WSM6-BMJ-YSU	GOD-BMJ-YSU
ETA-BMJ-MYJ	WSM6-BMJ-MYJ	GOD-BMJ-MYJ

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3. **RESULTS**

3.1 Performance at domain d02

Figure 2 presents the mean absolute error for each run performed in the study. For pressure (Fig 2a) the runs made using the BMJ scheme produced overall better results (smaller MAE) than those using KF. Also runs using YSU boundary layer scheme present lower MAE values than those using MYJ. For temperature (Fig 2b) the experiments that give the most consistent (and low) values of MAE are those that use the combination of ETA-YSU for microphysics and boundary layer schemes

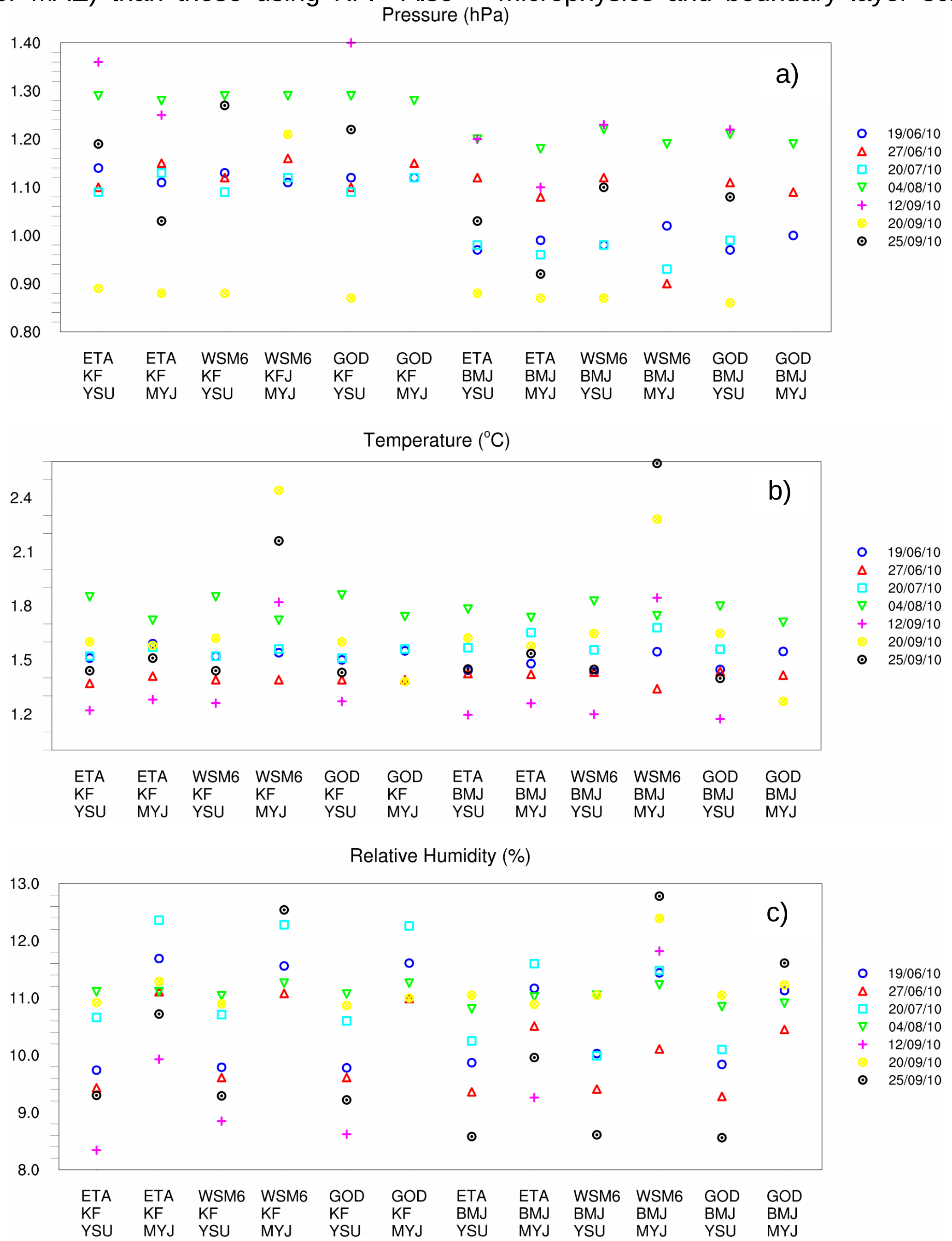

Figure 2. *The Mean Absolute Error of a) mean sea-level pressure, b) 2m air temperature and c) 2m relative humidity forecasts of WRF-d02 over Greece in the twelve sets of experiments.).*

Respectively, followed by those using WSM6 and YSU. There is a distinct separation between runs using YSU and MYJ as boundary layer scheme for relative humidity. Runs using YSU present systematically lower values of MAE. On the other hand runs using the combination of WSM6-MYJ shows the worst results for RH

3.2 Storm Characteristics

In Figure 3 and 4 the characteristics of the simulated convective activity (cloud top, clo-

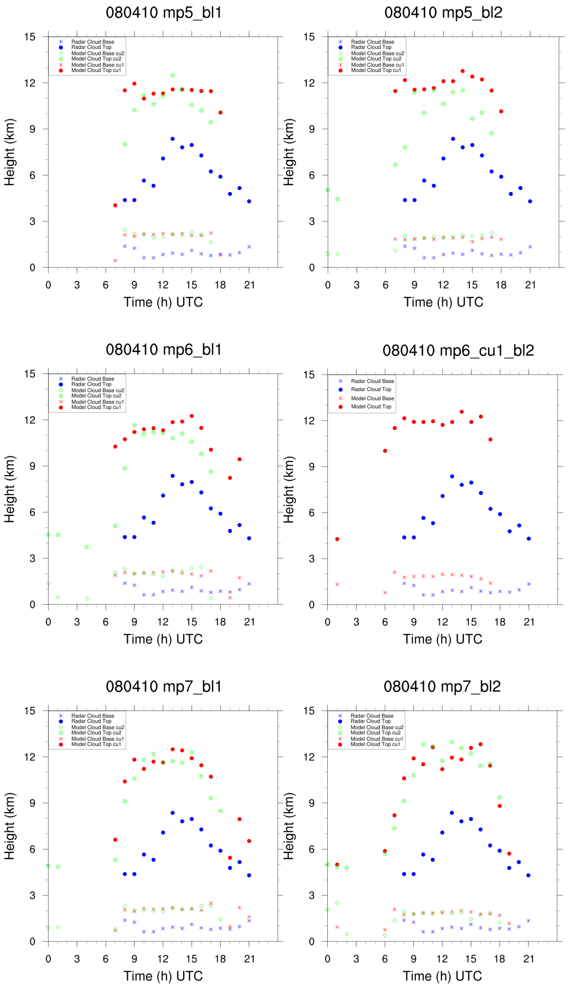

Figure 3. *Cloud top and base for grid points with composite reflectivity greater than 35 dbz (for 040810). Blue markers represent radar measurements, green markers model results for KF convection scheme and red markers results for BMJ convection scheme.*

oud base and maximum reflectivity) and those measured by the radar, for a selected case, are shown.

The UPP post processing module of WRF was used to calculate these fields from the model output and TITAN for the radar measurements. Convective activity was considered to occur when the composite (maximum throughout the atmospheric column) reflectivity, in the model or radar data, was higher than 35 dbz. This analysis was performed on a 140km x 140km region which covers most of Thessaly

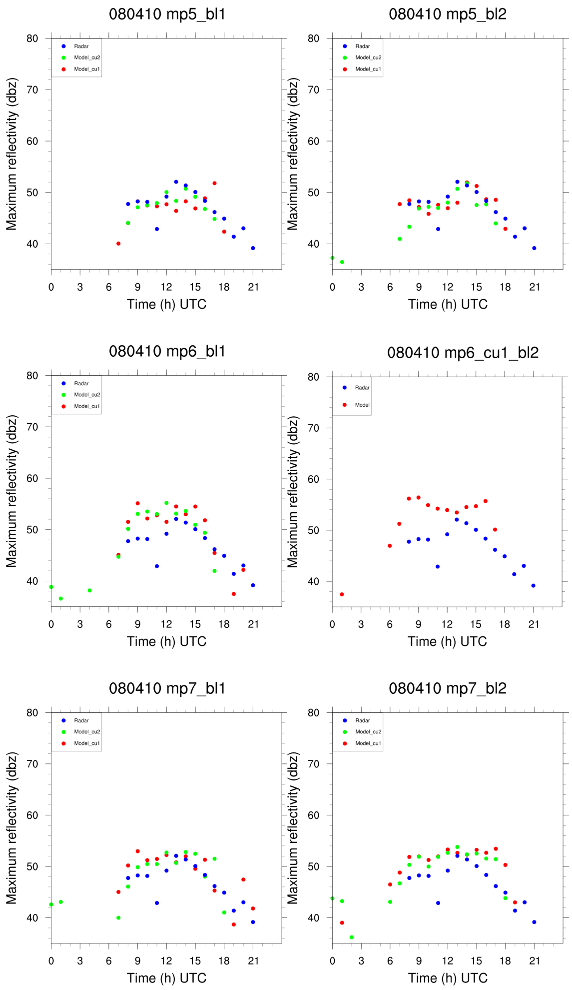

Figure 4. As in Figure 3 but for maximum reflectivity.

As can be seen from Fig. 3 and Fig. 4 the model predicts the onset of the high convective activity (>40dbz) accurately. Both cloud top and cloud base are overestimated as a result of different methodologies in the determination of these parameters for the model and radar data. In case of the radar data the cloud base and top are estimated as the lower and upper heights (inside the cloud) where the reflectivity is greater than 35dbz. For model data the whole cloud extend is considered if the composite reflectivity in the grid is greater than 35dbz. For the maximum reflectivity the best results can be obtained using the WSM6-YSU combination

3.3 Daily cycle at domain d03

The daily cycle of 2m temperature and relative humidity at two selected locations (Larisa and Anghialos, see Fig. 1 for exact locations) is presented in Fig. 5. For Larisa ETA-KF-MYJ is better in representing maximum and minimum temperatures while WSM6-KF-YSU shows an overall better behavior. On the other hand all the schemes

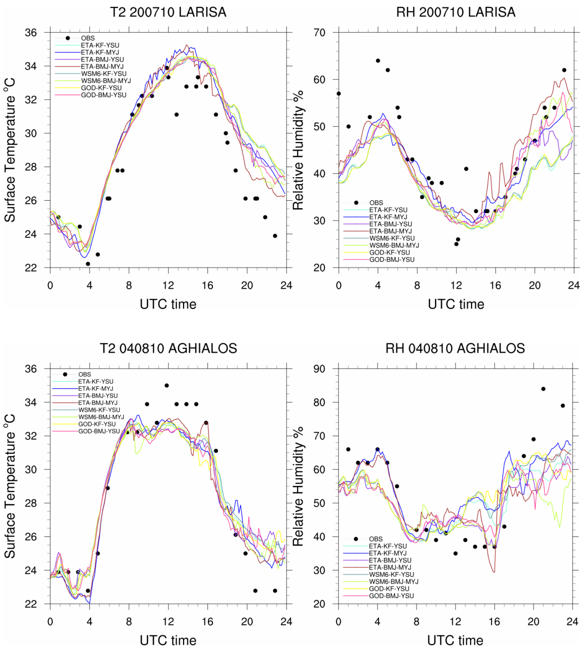

Figure 5. *Daily cycle of measured and simulated 2m temperature and relative humidity at Larisa (a and b; 20/07/2010) and Anghialos (c and d; 04/08/2010)*

miss the midday temperature maximum at Aghialos and the high values of relative humidity after the sunset.

4. **REFERENCES**

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5. ***ACKNOWLEDGMENTS***

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