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Sensitivity of WRF precipitation on microphysical and boundary layer parameterizations during extreme events in Eastern Mediterranean

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Contemporary atmospheric numerical models contain a large number of physical parameterization schemes in order to represent the various atmospheric processes that take place in sub-grid scales. The choice of the proper combination of such schemes is a challenging task for research and particularly for operational purposes. This choice becomes a very important decision in cases of high impact weather in which the forecast errors and the concomitant societal impacts are expected to be large. Moreover, it is well known that one of the hardest tasks for numerical models is to predict precipitation with a high degree of accuracy. The use of complex and sophisticated schemes usually requires more computational time and resources, but it does not necessarily lead to better forecasts. The aim of this study is to investigate the sensitivity of the model predicted precipitation on the microphysical and boundary layer parameterizations during extreme events.

The nonhydrostatic Weather Research and Forecasting model with the Advanced Research dynamic solver (WRF-ARW Version 3.1.1) is utilized. It is a flexible, state-of-the-art numerical weather prediction system designed to operate in both research and operational mode in global and regional scales. Nine microphysical and two boundary layer schemes are combined in the sensitivity experiments. The 9 microphysical schemes are: i) Lin, ii) WRF Single Moment 5-classes, iii) Ferrier new Eta, iv) WRF Single Moment 6-classes, v) Goddard, vi) New Thompson V3.1, vii) WRF Double Moment 5-classes, viii) WRF Double Moment 6-classes, ix) Morrison. The boundary layer is parameterized using the schemes of: i) Mellor-Yamada-Janjic (MYJ) and ii) Mellor-Yamada-Nakanishi-Niino (MYNN) level 2.5. The model is integrated at very high horizontal resolution (2 km x 2 km in the area of interest) utilizing 38 vertical levels.

Three cases of high impact weather in Eastern Mediterranean, associated with strong synoptic scale forcing, are employed in the numerical experiments. These events are characterized by strong precipitation with daily amounts exceeding 100 mm. For example, the case of 24 to 26 October 2009 was associated with floods in the eastern mainland of Greece. In Pieria (northern Greece), that was the most afflicted area, one individual perished in the overflowed Esonas river and significant damages were caused in both the infrastructure and cultivations. Precipitation amounts of 347 mm in 3 days were measured in the station of Vrontou, Pieria (which is at an elevation of only 120 m).

The model results are statistically analysed and compared to the available surface observations and satellite derived precipitation data in order to identify the parameterizations (and their combinations) that provide the best representation of the spatiotemporal variability of precipitation in extreme conditions. Preliminary results indicate that the MYNN boundary layer parameterization outperforms the one of MYJ. However, the best results are produced by the combination of the Ferrier new Eta microphysics with the MYJ scheme, which are the default schemes of the well-known and reliable ETA and WRF-NMM models. Similarly, good results are produced by the combination of the New Thompson V3.1 microphysics with MYNN boundary layer scheme. On the other hand, the worst results (with mean absolute error up to about 150 mm/day) appear when the WRF Single Moment 5-classes scheme is used with MYJ. Finally, an effort is made to identify and analyze the main factors that are responsible for the aforementioned differences.