16th Annual WRF User's Workshop| Boulder, Colorado | USA | 15 - 19 June 2015

Evaluation of the operational numerical weather predictions of the Daphne project

Tegoulias Ioannis*, Ioannis Pytharoulis, Theodore Karacostas, Stylianos Kotsopoulos, Stergios Kartsios and Dimitrios Bampzelis

Department of Meteorology and Climatology, Aristotle University of Thessaloniki, Greece

* Corresponding author: tegoulia@auth.gr

Aim

The numerical weather prediction model WRF-ARW 3.5.1 is used to provide operational forecasts and hindcasts for the rain enhancement project DAPHNE. The aim of this study is to analyze the model's performance during the operational phase of the project.

Data and Methodology

- **Model:** WRF-ARW Version 3.5.1
- **Domains:** Europe and northern Africa -d01, Greece -d02, Central Greece, Thessaly region -d03
- **Grid Spacing :** 15km, 5km and 1km
- **Topography and Land Use data :** Fine-resolution data (30'' x 30'')
- **Initial and Boundary Conditions:** GFS analyses and 3-hourly forecasts (0.5°x0.5° lat.-long.)
- **Vertical Levels:** 39 sigma levels (up to 50 hPa, increased resolution in the boundary layer)
- **Initial time:** 1200 UTC daily (d02 and d03 initialized at T+6 to reduce model spin-up)
- **Run Length:** 1.5 day

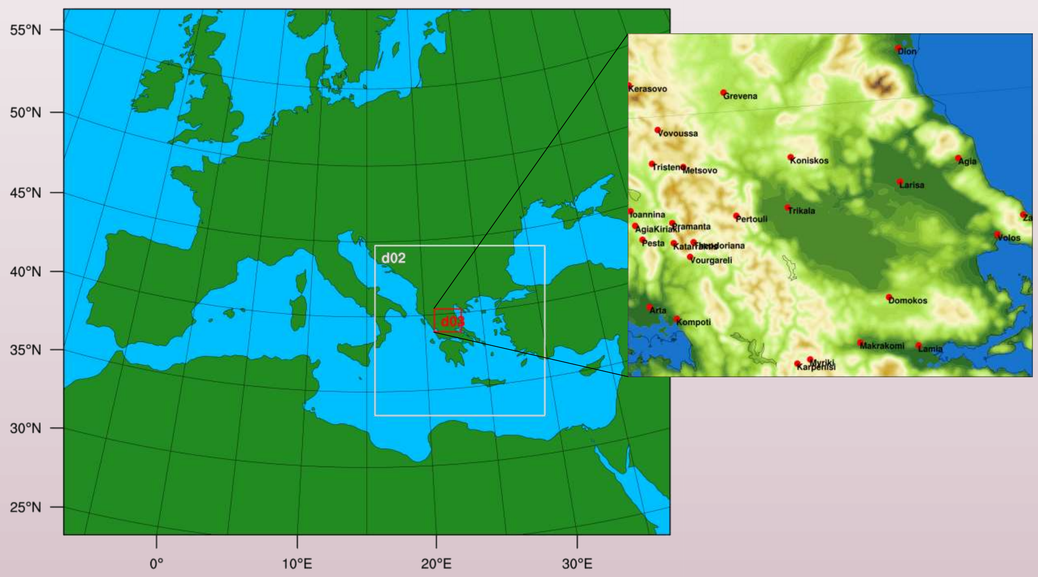

Fig. 1: Model domain setup and stations used for the evaluation (d03)

- **Longwave and shortwave radiation:** RRTMG
- **Soil physics :** NOAH Unified model
- **Microphysics :** Single-Moment 6-Class (WSM6)
- **Sub Grid Convection :** Kain-Frisch (KF)
- **Boundary Layer :** Yonsei University (YSU)

Period of interest: September - October 2014

Area of interest: Greece (d02) and Thessaly region (d03).

The model performance is assessed through statistical evaluation of the forecasts using 19 stations of the Hellenic National Meteorological Service for d02, while for d03, 27 stations of the National Observatory of Athens were used. The model value at the closest grid-point to the location of each station was utilized.

Model Performance over Greece (domain d02)

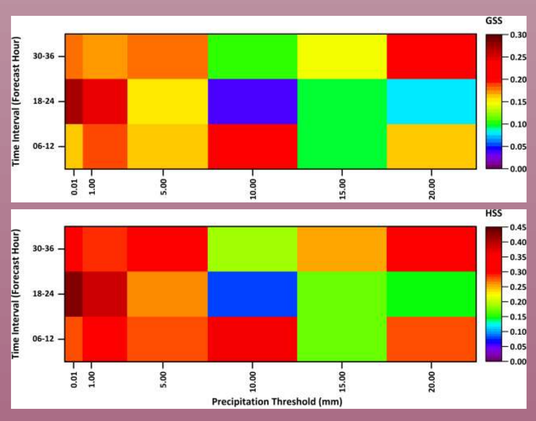

Fig. 2: The Gilbert Skill Score (a) and Heidke Skill Score (b) for 6 hourly accumulated precipitation as a function of threshold and forecast period for domain d02

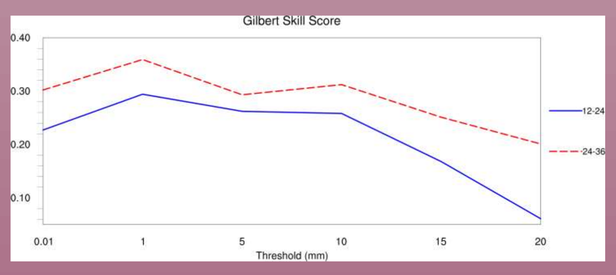

Fig. 3: The Gilbert Skill Score of 12 hourly accumulated precipitation as a function of threshold and forecast period for domain d02

Model Performance over Greece (domain d02)

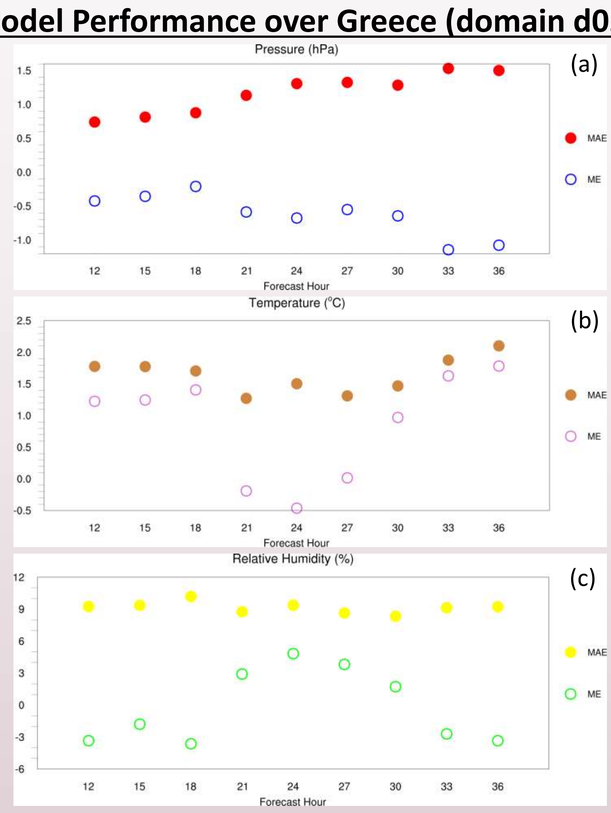

Fig. 4: The Mean Error and Mean Absolute Error of a) mean sea-level pressure, b) 2m air temperature and c) 2m relative humidity forecasts of WRF-d02 over Greece.

Model Performance over Thessaly (domain d03)

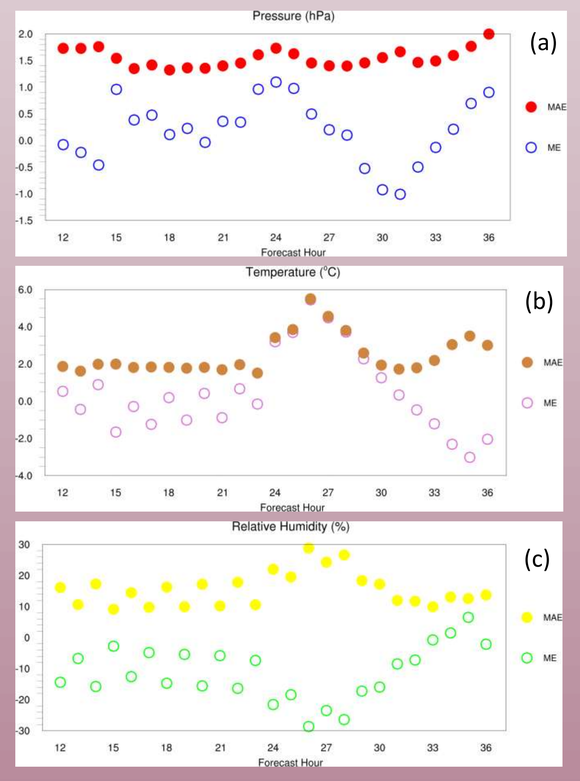

Fig. 5: The Mean Error and Mean Absolute Error of a) mean sea-level pressure, b) 2m air temperature and c) 2m relative humidity forecasts of WRF-d03 over Thessaly

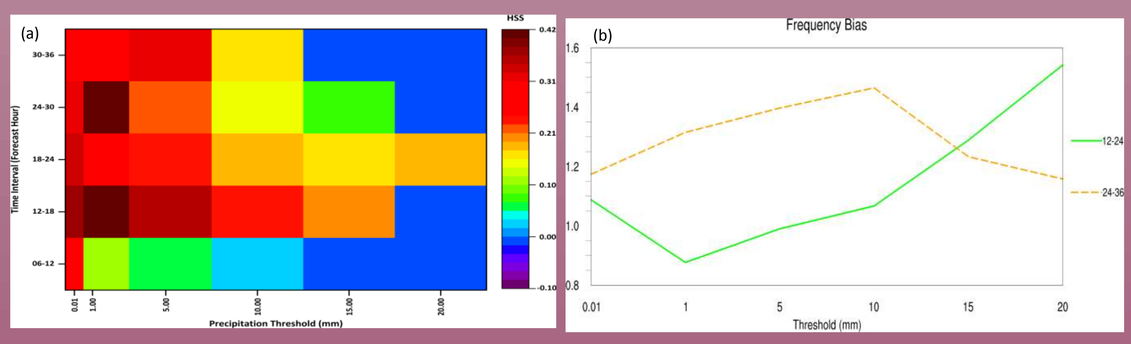

Fig. 6: Heidke Skill Score for 6 hourly accumulated precipitation (a), and Frequency Bias for 12 hourly accumulated precipitation (b) as a function of threshold and forecast period

Discussion

Concerning precipitation the Gilbert Skill Score and Heidke Skill Score (HSS) present satisfactory values for precipitation thresholds up to 10 mm (six hour intervals, d02, Fig 2). A systematically better behavior is evident for 24-36 hours lead time (12-00UTC) compared to 12-24 hours lead time (00-12UTC) in d02 (Fig 3).
At domain d02 the model underestimates mslp (Fig. 4a). For 2m temperature there is an overestimation during day time and an underestimation during night time (Fig. 4b). The opposite appears for 2m relative humidity (Fig. 4c). The MEs and MAEs are in agreement with the ones found in the literature for the Greek area.
In Thessaly area (d03) the MAE of sea level pressure is almost constant throughout the forecast period while the ME presents a diurnal variation (Fig 5a). Temperature forecast exhibit a positive peak in ME at midday (Fig 5b, 24 to 27 hours forecast lead time) accompanied by a negative peak in relative humidity (Fig 5c).
Precipitation forecast performance in the inner domain (d03), as expressed using the HSS is tolerable (with the exception of the first hours of the forecast) for precipitation thresholds up to 15 mm (Fig 6a). The same applies to Frequency Bias of the 12 hour accumulated precipitation for the 12-24 hours forecast time (Fig 6b).

Acknowledgements: This research work has been co-financed by the European Union (European Regional Development Fund) and Greek national funds, through the action "COOPERATION 2011: Partnerships of Production and Research Institutions in Focused Research and Technology Sectors" (contract number 11SYN_8_1088 -DAPHNE) in the framework of the operational programme "Competitiveness and Entrepreneurship" and Regions in Transition (OPC II, NSRF 2007-2013)