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Impact of high resolution elevation and land use data on simulated convective activity over Central Greece

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Introduction

The main objective of the **project DAPHNE** is the assessment of the agricultural drought in the region of Thessaly (Fig.1), in central Greece by means of Weather Modification.

The aim of this research is to investigate the impact of very high spatial resolution topography and land use data in the characteristics of convective activity, simulated by the non-hydrostatic Weather Research and Forecasting model, with the Advanced Research dynamic solver (WRF-ARW, v3.5.1).

Data and Methodology

Numerical Model:	WRF-ARW (ver.3.5.1), 2-way telescoping nesting (Fig. 1)
Grid increment:	15km x 15km (D01) - Europe
	5km x 5km (D02) - Greece
	1km x 1km (D03) - Central Greece – Thessaly region
Initial time:	1200 UTC before each day of interest
Duration:	36 hours
Vertical levels:	39 sigma levels (up to 50 hPa)
Initial and lateral boundary conditions:	6-hourly ECMWF operational analyses (0.25°x0.25° lat.-long.)
Sea-Surface Temperatures:	NCEP (1/12°x1/12° lat.-long.)
Microphysics:	WRF Single Moment 6-classes (WSM6)
Cumulus convection:	Kain-Fritsch
Longwave/ Shortwave Radiation:	RRTMG
Surface Layer:	Monin-Obukhov (MM5) scheme
Boundary layer:	Yonsei University
Soil Processes:	NOAH Unified model
Topography data:	USGS (30 sec – default)
	SRTM (3s, Shuttle Radar Topography Mission v.4)
Land use data:	USGS (30 sec – default)
	CORINE Land Cover 2000 raster data (3 sec, v.17)

- Six (6) representative days with different upper-air prevailing synoptic conditions from previous work, where selected in order to investigate the impact of topography and land use in convective activity, in the area of interest (black frame in Fig.1b).
- The (6) prevailing upper-air synoptic circulation types over Greece were: 1) zonal flow (ZON), 2) northwest flow (NW), 3) closed low (CLO), 4) cut-off low (CUT), 5) southwest flow (SW), 6) open trough (L1).
- High resolution elevation data (SRTM) in conjunction with better representation of land use (CORINE data set) are ingested into the innermost domain (Fig.1b). A total of 24 simulations were performed.
- Convective activity is considered to occur at the locations, where the max reflectivity of the column -in the model or radar data- is higher than 35 dBz.

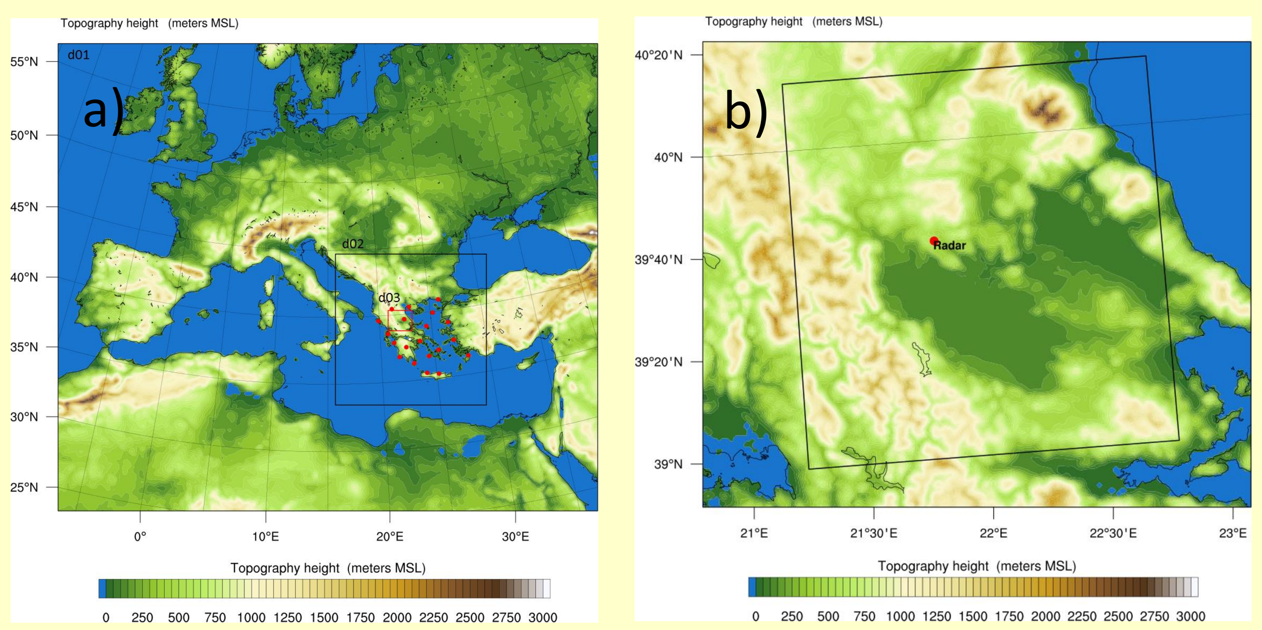

Figure 1. Domain configuration (a) with topography height and the inner domain (b) of Thessaly region. The red dots in (a) indicate the locations of available HNMS stations, while in (b) the location of the weather radar is shown with the black frame encompassing the radar data.

Results

Figure 2. Timeseries of hourly values in the area of interest (black frame in Fig. 1b) of maximum reflectivity, maximum cloud top and average cloud base, average convective area and average volume of convective activity, at locations with > 35dbz, on 03 July 2009.

	Skill Score			
	tUSGS-lUSGS	tSRTM-lUSGS	tUSGS-lCORINE	tSRTM-lCORINE
MSLP (hPa)	0.00%	0.10%	-0.20%	-0.05%
TEMP (K)	0.00%	0.12%	-0.47%	-0.25%
RH (%)	0.00%	0.08%	0.44%	0.01%
WIND (m/s)	0.00%	0.00%	0.49%	-0.15%

Table 1. Skill scores of the four (4) topography – landuse configurations for WRF-d02, using the HNMS stations (Fig. 1a), for all six (6) case studies. Each day with tUSGS-lUSGS configuration acted as control run.

	Area (km^2)		Reflectivity (dbz)		Cloud top (km)		Cloud base (km)		Storms volume (km^3)	
	ME	MAE	ME	MAE	ME	MAE	ME	MAE	ME	MAE
tUSGS-lUSGS	-37.30	43.69	-7.69	14.89	-0.43	2.97	-0.60	0.91	-130.08	139.67
tSRTM-lUSGS	-32.61	38.48	-5.62	16.53	-0.45	2.65	-0.63	0.87	-115.09	118.54
tUSGS-lCORINE	-39.30	43.27	-8.21	14.06	-0.95	2.51	-0.53	0.78	-135.10	138.89
tSRTM-lCORINE	-37.09	41.09	-8.88	14.77	-1.13	2.38	-0.71	0.81	-131.89	133.10

Table 1. Mean Error (ME) and Mean Absolute Error (MAE) of average area (km^2), maximum reflectivity (dbz), maximum cloud top (km), average cloud base (km) and average volume of convective activity (km^3) on 03 July 2009, in the area of interest, using hourly values from the model and the weather radar.

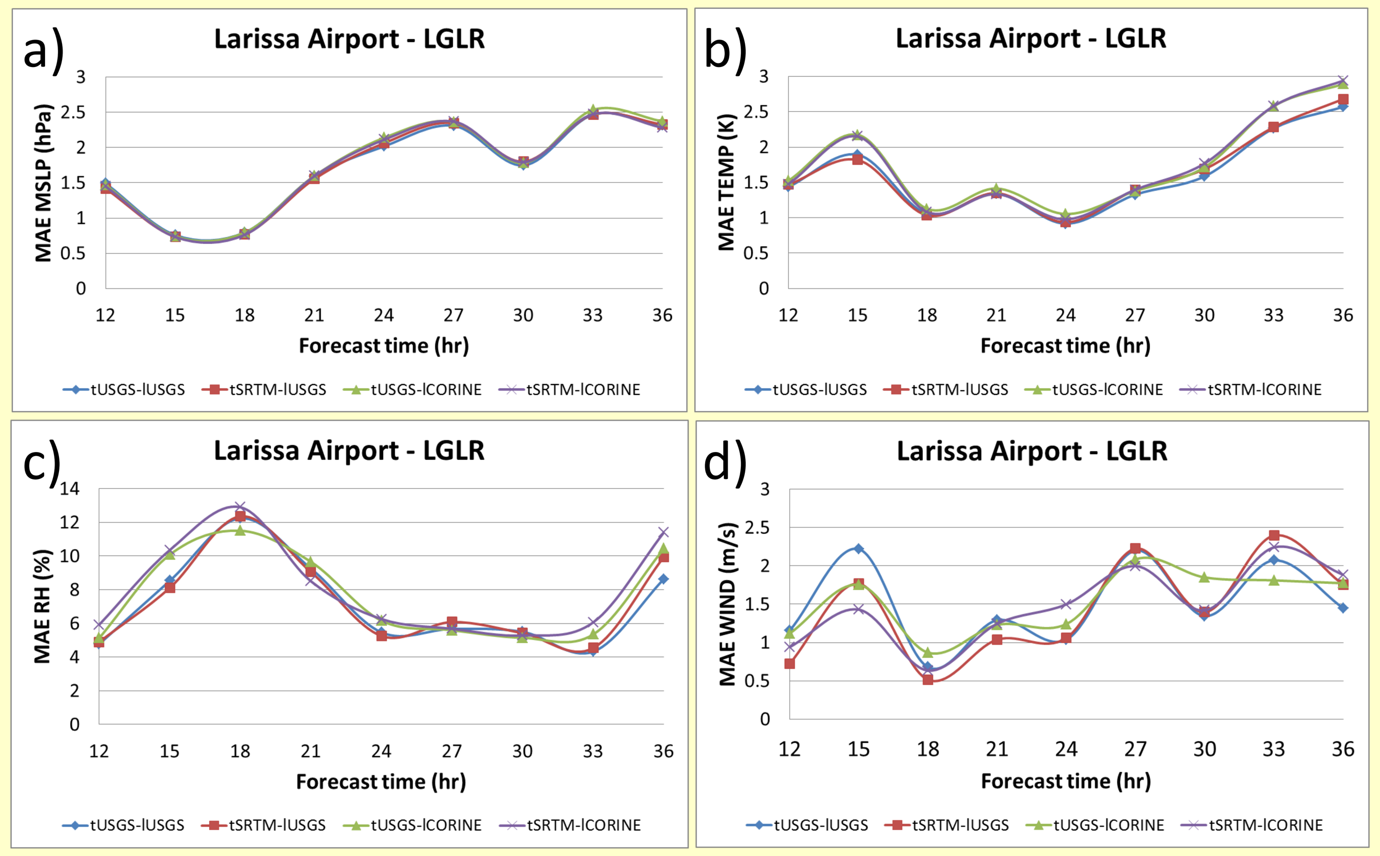

Figure 3. The Mean Absolute Error (MAE) of a) mean sea level pressure, b) 2m temperature, c) 2m relative humidity and d) 10m wind speed, at Larissa Airport (LGLR – WRF-d03), as a function of time for the four (4) topography – landuse configurations.

Discussion

- The use of high resolution elevation data, tSRTM-lUSGS configuration, (Table 1.) seems to improve slightly the overall forecast (WRF-d02) in terms of mean sea level pressure, 2m temperature, 2m relative humidity and 10m wind speed. The statistical evaluation performed for 24 hours starting at 00UTC of each representative day (T+12-T+36)
- In the area of interest (Fig. 1b), at Larissa Airport (39°38′56.76″N, 22°27′55.63″E) no significant change in the MSLP's MAE is shown (Fig.3a) for all the configurations, while the tSRTM-lUSGS configuration gives, in general better representation of 2m temperature and 10m wind speed for all six (6) cases. Greater MAEs are produced for the 2m relative humidity, a variable which is overestimated the most by the model.
- The representative case of 03 July 2009 (Fig. 2), despite some discrepancies on the onset and termination of convective activity, was simulated quite well by the model in terms of maximum reflectivity, cloud depth, average convective area and average volume of convective activity, for all configurations. However, differences occurred in the intensity of the phenomena.

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