APPLICATION OF MM5 MODEL IN THE NORTH-WEST AREA OF GREECE-FIRST RESULTS

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INTRODUCTION-MODEL USED

In the last 20 years numerus meteorological models were initialised and applied for various purposes woldwide. The growing computer capacity became easier the development of sophisticated models that described the meteorological phenomena in a rather satisfying manner. Nowadays nonhydrostatic meteorological models are using to predict meteorological phenomena and the future weather in general, in a operational basis. Although that significant improvement was made in this sector, much work must be done to simulate the future weather phenomena in small scales.

In Greece there are some models working in operational basis by the National Meteorological service and some Research Institutes. Recently the University of Ioannina, has established the MM5 model to use it for research and educational purposes. These are the first results of a case study made with the aid this model.

The Fifth-Generation Penn State/NCAR Mesoscale Model Version 5 or MM5 (Grell et. al. 1995) originated from a mesoscale model developed by Richard Anthes at Penn State University, documented in Anthes and Warner (1978). The MM5 has grown into a community model with users continually improving and adding features. These include a multiple nest capability, a nonhydrostatic dynamics, a four-dimesional data assimilation capability as well as more physics options . The model itself is supported by several programs, which are known as the MM5 modeling system.

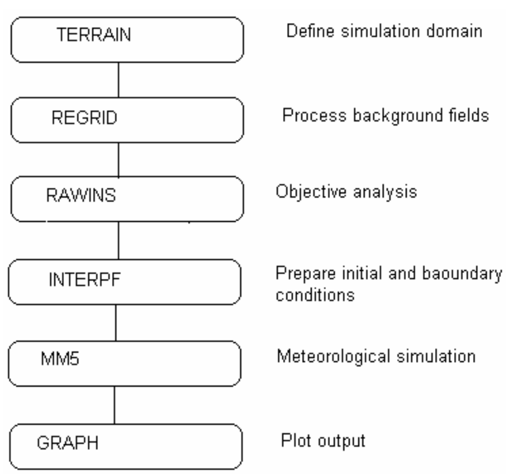

Figure 1. Flow chart of MM5 modeling system.

The first program, TERRAIN, is used to define the MM5 simulation domains. The domains for the meteorology simulations are defined by several parameters, which are the number of grid points in each horizontal dimension, grid spacing , center latitude , center longtitude and number of nested domains. This program makes use of high-resolution global terrain and land use data sets to create values for each grid point for terrain height and land use specification. The TERRAIN program described by Guo and Chen (1994).

The program REGRID generates first-guess fields for the model simulation by horizontally interpolating a larger scale data set to the simulation domain. These fields are used to generate lateral boundary conditions for the coarse domain simulations , and they form the basis for the objective analysis. Also program REGRID calculates latitude , longitude, mapscale factors and Coriolis parameters at each grid point to be used by MM5.

Next program , RAWINS, performs an objective analysis by blending the first-guess fields generated by REGRID with twelve hourly upper air and three hourly surface observasions. The objective analysis are performed on pressure levels. The program RAWINS is described by Manning and Haagenson (1992).

The INTERPF program is disigned to fill miltiple purposes in the MM5 system. First, the analyses from program RAWINS are interpolated to MM5's staggered grid configuration and from their native vertical coordinate to MM5's vertical coordinate. In addition the state variables are converted as necessary. The analyses from one time are interpolated to provide MM5's initial conditions, while analyses from all times are interpolated to generate MM5's lateral boundary conditions. Second the MM5 output from the parent domain is interpolated to the nest to provide initial and lateral boundary conditions for the nested run.

The main program MM5 is a complex mesoscale meteorological model. This program uses full physics equations of momentum, thermodynamics and moisture. It can be run using either hydrostatic or non-hydrostatic equations. The state variables include temperature, specific hummidity, grid relative wind componets and pressure. The state variables are mass weighted with a modified surface pressure throughout the model. In the non-hydrostatic equations, pressure, temperature and density are defined by reference state and pertubations from the reference state. The vertical (sigma) coordinate is defined as a function of reference pressure in the non-hydrostatic model and it is time independent. Descriptions of the MM5 program are found in Grell et al. (1994) and Dudhia et al. (1998).

Finaly program GRAPH is a plot utility , program LITTLE_R is as same as program RAWINS , program NESTDOWN create noe-way nest or nested model input and the program INTERPB is interpolate model sigma level data to pressure levels.

NUMERICAL SIMULATIONS-THE CASE STUDY

For the numerical simulations the non-hydrostatic mesometeorological model MM5 was applied. We use two domains, with the same horizontal resolution (9 km). For the vertical resolution every domain used 23 vertical levels. For the horizontal resolution the analysis was 35x41 grid points for the first and 49x52 points for the second domain, covering an extent of 341X369 Km^2 for the first and 441X468 Km^2 for the second domain. The center of the two domains had geographical coordinates, latitude 40^o and longitude 25^o. The meteorological data used, for the archives of ECMWF, are the data from the 13th of March 1993. During this day an anticyclonic system was covered the central and eastern Mediterranean. This synoptic situation began at 10th of March and lasted 5 days. In the 850 hPa, 700 hpa and 500 hPa a ridge was established. Figure 2 shows the area which was covered by the domain. The simulation was started at 00 UTC and lasted 24 hours. Due to the lack of space we presented the wind fields only from the starting hour of the simulation up to 12 UTC. In Figure 3 the topography of the domain 2 as well as the land use types used for the simulation are shown in figure 4 the surface pressure at time 00 UTC, is shown. As we could see the area of Greece is covered by a rather typical Anticyclonic situation.

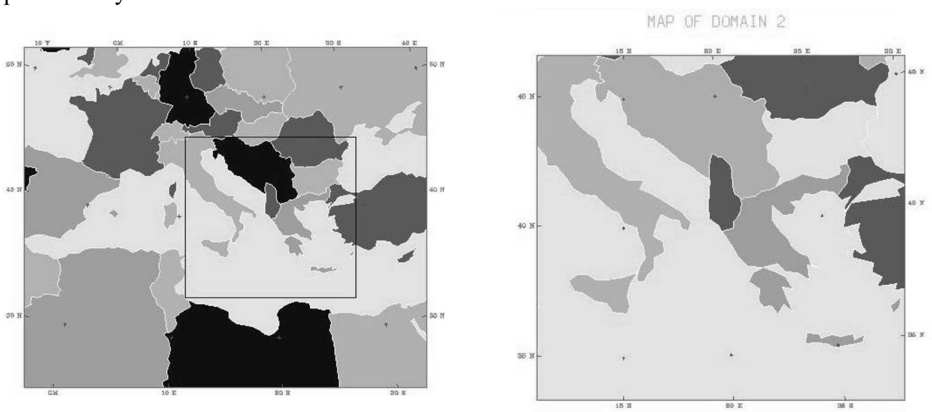

Figure 2. Maps of domains 1 and 2.

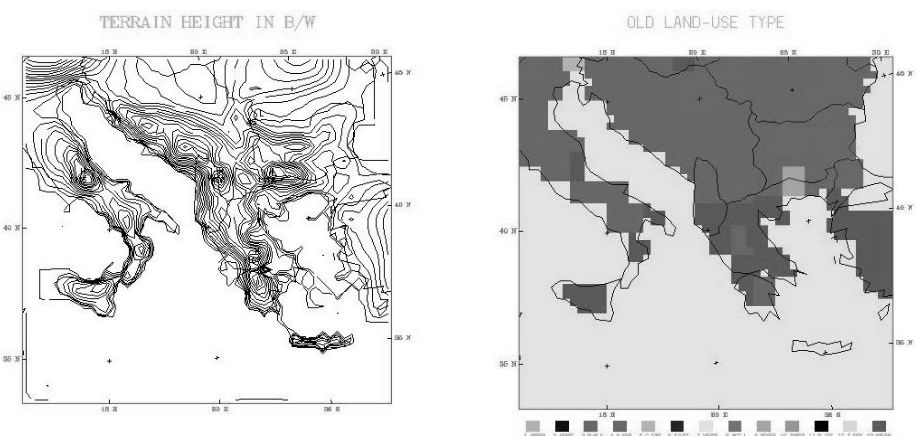

Figure 3 . The topography and the map of land-use for domain 2.

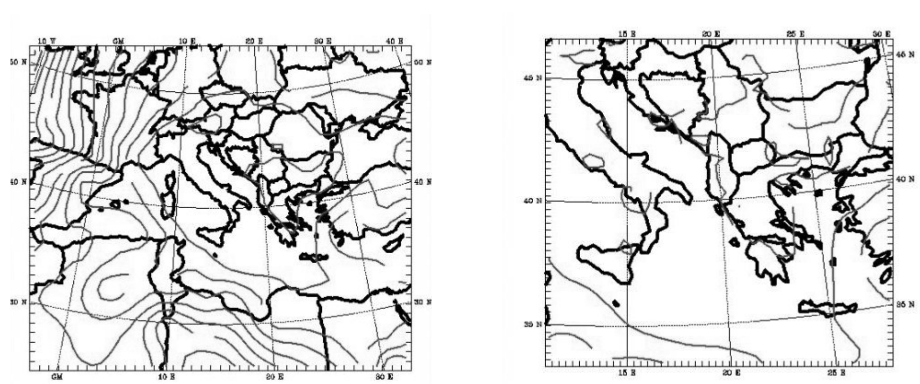

Figure 4 . Surface pressure at 00 UTC.

Figures 5 descibe the wind field in the surface at 00 UTC. As we could see in the Western Mediterranean a Low is shown having its centre in the area of Balearides and the Gulf of Leon. The winds are from northern directions in the Italian peninsula and over Adriatic Sea and the Balkans, while in the Tyrrenean and Ionian seas the winds are from NW directions. In the Central and Eastern Meditteranean and consequently over Aegean the winds were from western directions. As we could see, from figure 5, a vortex, centered in the southern Bulgaria, is responsible for the rather circural flow shown in this area. For all the Balkans the winds are blowing for Northern dircections, with the exception of central and southern Greece. In the central Greece (Regions of Epirus and Thessalia) the winds are from NW directions and in the southern Greece (Regions of Continental Greece and Pelloponisos) the winds are from western directions.

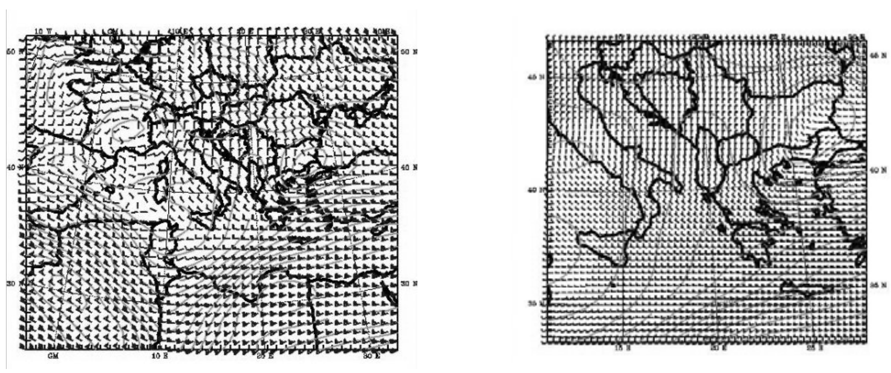

Figure 5 . The wind in domains 1 and 2 at time 00 UTC.

Six hours later the wind fields over Meditteranean are significantly changed (Figures 6). The vortex of the southern Bulgaria was moved over northern Aegean Sea, with its center over Lemnos island, and the wind flow was turned to NE directions over Bulgaria and eastern Macedonia and Thrace, while over Romania the wind flow is NW. The wind flow is from Northern directions over Servia, Croatia, FYROM and Albania. Over NW Greece a NW flow remains, while over southern Greece and the southern Aegean Sea the winds are blowing from western directions. The winds are blowing from southern, especially southwestern, directions in the western Meditteranean, while the vortex over the Gulf of Leon it seems that is moved over the Tunisian coast, so the wind field over Sicily, is for southern directions.

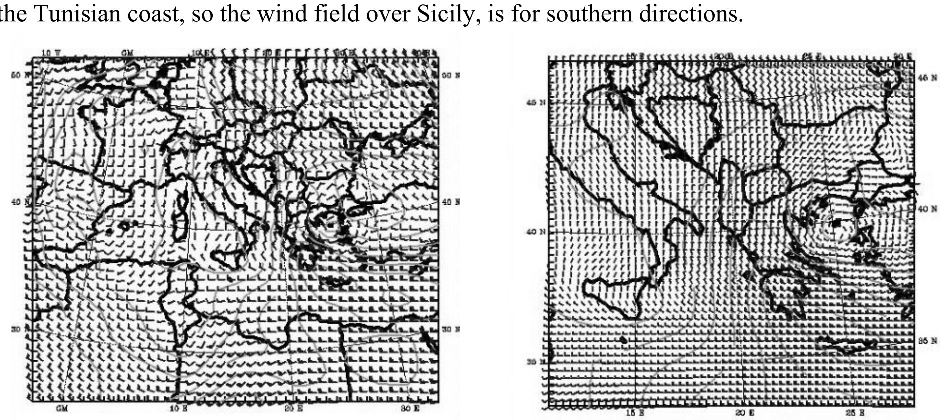

Figure 6 . The wind in domains 1 and 2 at time 06 UTC.

Twelve hours after the starting of the simulation (Figures 7), the vortex over the Tunisia remains stationary, but the flow field over the Italian penisula is completely changed since the winds are mainly from southern directions. The winds over NW Greece are also from NW dierctions, while the flow field is also remains unchanged of southern Greece, southern Aegean Sea and Eastern Mediterranean. The vortex which was located over the northern Aegean Sea is moving slowly over the Minor Asia coasts so the winds are from NE directions over Bulgaria, FYROM and Macedonia, while are turned from NW directions over central Aegean sea.

For the rest hours of our simulation the wind flow remains practically unchange over NW Greece, since the low over Aegean is moved over Turkey and the low over Tunisia, remained in the same site.

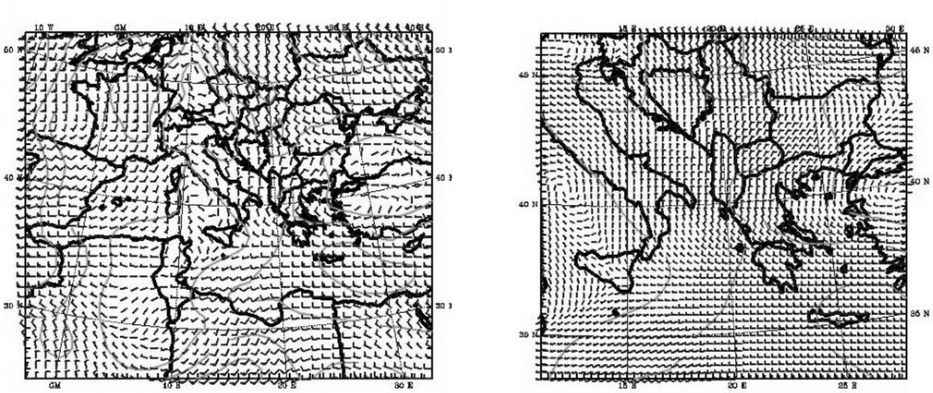

Figure 7 . The wind in domains 1 and 2 at time 12 UTC.

CONCLUSIONS

These are the first results of a simulation made by the MM5 model established in the University of Ioannina. Of course is a first attempt and now our group is working to run applications with lower resolution in order to describe mesoscale circulations also.

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