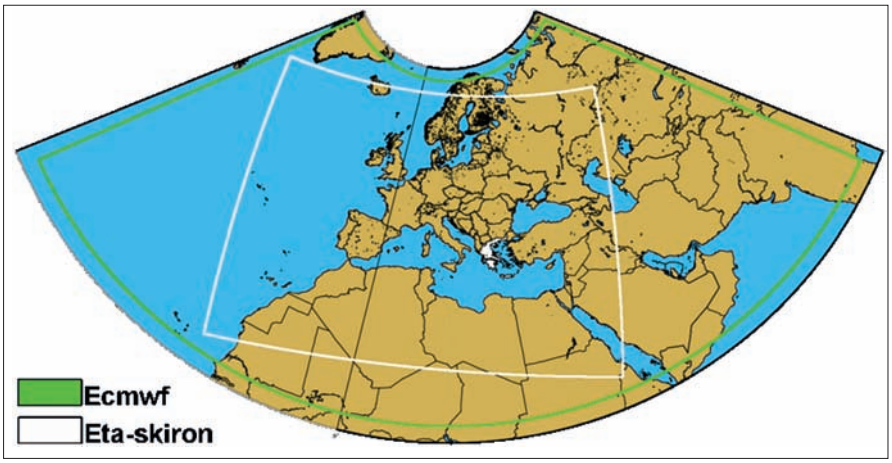
High resolution NWP model in operational use at HNMS

The Hellenic National Meteorological Service (HNMS) is responsible for providing meteorological support to the state, the military as well as to the Greek public in order to protect human life and property, and to support the national economy. To this end, HNMS operates two high-resolution Numerical Weather Prediction (NWP) systems - COSMO-GR and SKIRON/Eta - which provide detailed deterministic forecasts for an extended area around Greece on a daily basis.

Both NWP models are well-known and widely used by various meteorological services, universities and research institutes around the world. In addition, gridded forecast and analysis data are received daily from the ECMWF Integrated Forecasting System (IFS). The outputs from all the NWP models are combined with radar, observation and satellite network data to provide the HNMS staff with a plethora of tools to assist their work (Scrimizeas P. 2009).



▲ *Figure 1*
Integration area of SKIRON-ETA

The Regional Weather Forecasting System SKIRON/Eta was developed by the Atmospheric Modelling and Weather Forecasting Group of the University of Athens (Kallos, 1997) for operational use at HNMS. It is based on the NCEP/Eta model (Janjic, 1994), which was originally developed at the University of Belgrade. SKIRON is a full physics atmospheric model with several unique capabilities that make it appropriate for regional/mesoscale simulations in regions with highly variable physiographic characteristics. It has the unique capability to use the "step-mountain" Eta vertical coordinate' and it uses non-hydrostatic dynamics. The non-hydrostatic model appears to be computationally robust at all resolutions and efficient in NWP applications (Janjic et al., 2001). Sophisticated parameterizations are utilized in order to represent the various physical processes such as radiation, convection, grid-scale precipitation and clouds, boundary layer and soil processes. The operational domain of SKIRON/Eta at HNMS is 26N-56N, 20W-40E with a spatial resolution of 0.06o (~6-7km). (FIG. 1)

The limited-area model COSMO-GR (formerly known as LM) is based on the Lokal-Modell (LM) (Steppeler et al., 2003) of DWD (Deutscher Wetterdienst). It is based on the primitive hydro-thermodynamical equations describing compressible non-hydrostatic flow in a moist atmosphere without any scale approximations.

Over the last decade, the non-hydrostatic numerical weather prediction model COSMO-GR has evolved into one of the main tools used by HNMS to create localized forecasts. During this period, the COSMO model has undergone significant developments within the operational framework of the COSMO Consortium which includes the national meteorological services of Germany, Greece, Italy, Switzerland, Poland, Russia and Romania as well as numerous European universities and research institutes.

The operational domain of COSMO-GR covers an area with a longitude range of 45o and a latitude range of 24.5o with a horizontal resolution of 0.0625o (~7km) Observations are also assimilated

employing a nudging analysis scheme (Schraff, 2003).

In parallel, through a technique based on a one-way nesting method, COSMO-GR is running over the wider area of Greece with a horizontal grid of 0.02o (~2 Km). (COSMO_GR-2) (FIG 2.) The results have been systematically evaluated as the model has approached operational use (Andreadis T. et al, 2010).

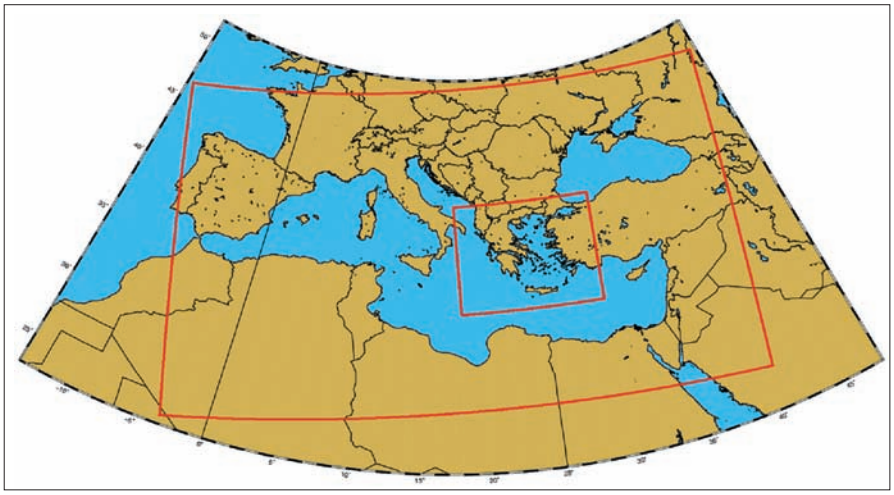


Figure 2

Integration area of COSMO-GR_7 and of COSMO-GR_2

Both models use initial and 3-hourly lateral boundary conditions from ECMWF (at 0.25x0.25o resolution). They are integrated on an IBM HPC Cluster 1600. Each computing node of the system is an IBM pSeries 655 with 8-way 1.7GHz Power4 central processing units and 16GB of memory interconnected with IBM's High Performance Switch (HPS 7045). The models run twice a day (00h and 12h analysis) with a forecast horizon of 72 hours (Table 1).

In order to determine the quality of the NWP products of COSMO-GR, SKIRON/Eta and to gain insight into their accuracy and usefulness, a verification process is essential. Through verification, one can monitor, compare and improve the quality of the forecasting systems. At HNMS, a versatile, automated verification system was developed and has been in operation since the end of 2006 in order to provide objective statistics for the performance of the different NWP models. The forecast values of weather parameters are compared with synoptic meteorological data from the HNMS's operational network of stations, and a range of statistical scores is calculated on a daily, monthly and yearly basis. (Gofa et al, 2008)

HMNS is responsible for the dissemination (via SafetyNet®) of Weather and Sea Bulletins for Shipping and Warnings for the Mediterranean Sea and the Black Sea. The Hellenic Navy Hydrographic Service is responsible for NAVTEX–MSI broadcasts which include the above mentioned meteorological information.

HNMS provides Weather and Sea Bulletins for Shipping and Warnings for the Eastern Mediterranean Sea and the Black Sea, for 36 forecast regions (FIG.3).

A wave model (WAM) (an ECMWF program calculating wave height and direction) is run, using a 24-hour

	SKIRON-ETA	COSMO.GR_7	COSMO.GR_2 (preoperational phase)
Points	976 x 720	649 × 393	501 × 401
Spatial Resolution	0.0625° (~7 Km)	0.0625° (~7 Km)	0.02° (~2 Km)
Timestep	30 sec	30 sec	15 sec
Forecast Horizon	72 hours	72 hours	48 hours
Boundary Conditions	IFS (ECMWF) 3h	IFS (ECMWF) 3h	COSMO.GR 7km 1h

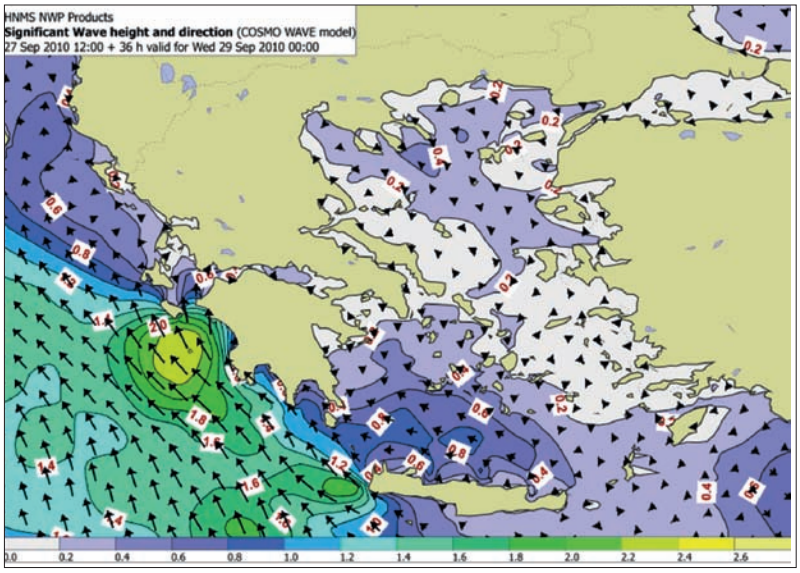
TABLE 1: High resolution NWP models at HNMS

Figure 3

East Mediterranean Forecast Regions

Figure 4

Significant Wave height and direction from WAM model



analysis from ECMWF (every 6 hours) and a 48-hour forecast from COSMO-GR_7 (every 3 hours). It produces 0.04o output over the entire the Mediterranean Sea. We use 00h and 12h runs (FIG4).

(This article is composed of excerpts from papers 1,2,3 of the references list, written by colleagues working in the HNMS Research Department).

P. **Giannopoulos**

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