WP10

Partner info			
N°	17	Acronym	MF
Subtask info			
N°	10110	Title	Global surface atmospheric fields from analyses and forecasts

Abstract

This task is n continuation from a similar one in the MFSPP and ADRICOSM projects and has been completed with two adaptation steps, made necessary by the MFSTEP context.

Data and methods

The main work at Météo-France has been to ensure a correct delivery of AGCM1 atmospheric model products. No major incident was noted. The server used to provide the data was changed, without any impact on the delivery process.

The scientific involvement has been twofold: Regular control of the fields produced and scientific or technical hot line in case of problems. The regular checking of the delivery process has been made by technicians involved in similar projects hence with efficiency.

Following the request from the oceanic modelling team in Bologna, some developments were completed mid-April 2003 in order to provide the atmospheric field 10 to 12 hours earlier every Wednesday.

The other new element concerns the change of domain of OGCM that made necessary to shift from 6°W to 19°W the western edge of the domain on which AGCM1 data are prepared. The work was done early January 2004 with a first effective implementation on 21/1/04. A catch-up computation was also done to cover a-posteriori the first part of January 2004. The two productions (old and new domains) will run in parallel until early March, when the old domain production will be discontinued.

Results

The procedure is now stable and well monitored for its use in pre-TOP and TOP.

Deliverable state

Del Number	Description	State	Dissemination date
D01	Data set (to be produced routinely for the whole MFSTEP period): AGCM1 surface data for forecasting and development studies.	Completed	21/1/04

Partner info			
N°	17	Acronym	MF
Subtask info			
N°	10120	Title	Preparation of operational LAM for Western Mediterranean Sea

Abstract
No concrete work is reported for this task, since most of its content was made obsolete by the decisions of the WP8910 meeting in Athens, in June 2003.

Data and methods
Since it was decided in Athens that both LAM1 and LAM2 should cover the whole Mediterranean area and, if possible, even the Atlantic part of the OGCM domain, the provision of LAM data on the sole Western Mediterranean basin by Météo-France became unnecessary. The envisaged procedure to merge and harmonise data at the border with the Central Mediterranean basin also became redundant.
Since there is now a 'full' coverage by both LAMs, there should neither be any need for a back-up procedure based of on a 0.1° post-processing of the ARPEGE coupling model (AGCM2) in Toulouse. However some dissymmetry between the two LAM productions (only CHMI follows the AGCM2 data assimilation cycle with its own 'blending' cycle) led to still prepare it in a stand-by mode, prepared to be activated on a demand by some oceanographers, if any.

Deliverable state

Del Number	Description	State	Dissemination date
D02	Prototype: LAM1 implemented in the W M and AGCM2 post-processing at 0.1° <u>Remark</u>: The LAM1 was finally implemented in a domain encompassing the whole OGCM area and hence all the Mediterranean basins. The back-up type AGCM2 (ARPEGE global model) post-processing procedure is ready and in stand-by, awaiting any user request (that should not in principle be necessary since LAM1 is covering the whole area and provides forcing data not only for the forecasting part of the exercise but also for its assimilation part).	Completed	29/2/04

Partner info			
N°	20	Acronym	CHMI
Subtask info			
N°	10125	Title	Preparation of operational LAM for the Mediterranean Sea

Abstract
Subtasks 10120_2, 10125 and 10130 were modified at the Athens joint WP8910 meeting. According to the meeting conclusions, there shall be two LAM models (LAM1 and LAM2) implemented, both covering whole Mediterranean sea and also OGCM domain, if possible; with coupling provided by AGCM2 (Arpege global model).
A short description of the dedicated version of the Aladin limited area numerical weather prediction (NWP) system implemented on the NEC/SX6 computer at Czech Hydrometeorological Institute in Prague in the frame of the Mfstep project with the aim to provide the atmospheric forcing for the ocean modeling community, is given. This dedicated version of the Aladin model will be referenced as Aladin/Mfstep in the text (also recognized as LAM1 in the Mfstep DoW).

Data and methods

Model domain

Aladin/Mfstep domain covers the area of the Mediterranean sea, Black sea and a part of the Atlantic ocean, as shown on Figure 1, with horizontal resolution of 9.5 km, having 589x309 points. The Lambert projection is used with the reference point [2.58E; 46.47N]. The domain centre is at [9.81E; 41.95N]. The elliptical spectral truncation is 299/159 on a so-called 'linear grid'. Vertically there are 37 irregularly distributed levels from 17m above the surface at the bottom to 5hPa on the model top. The model time step is 400s.
More details about the Aladin model (physics, dynamics) can be found in WP10/D8 report.

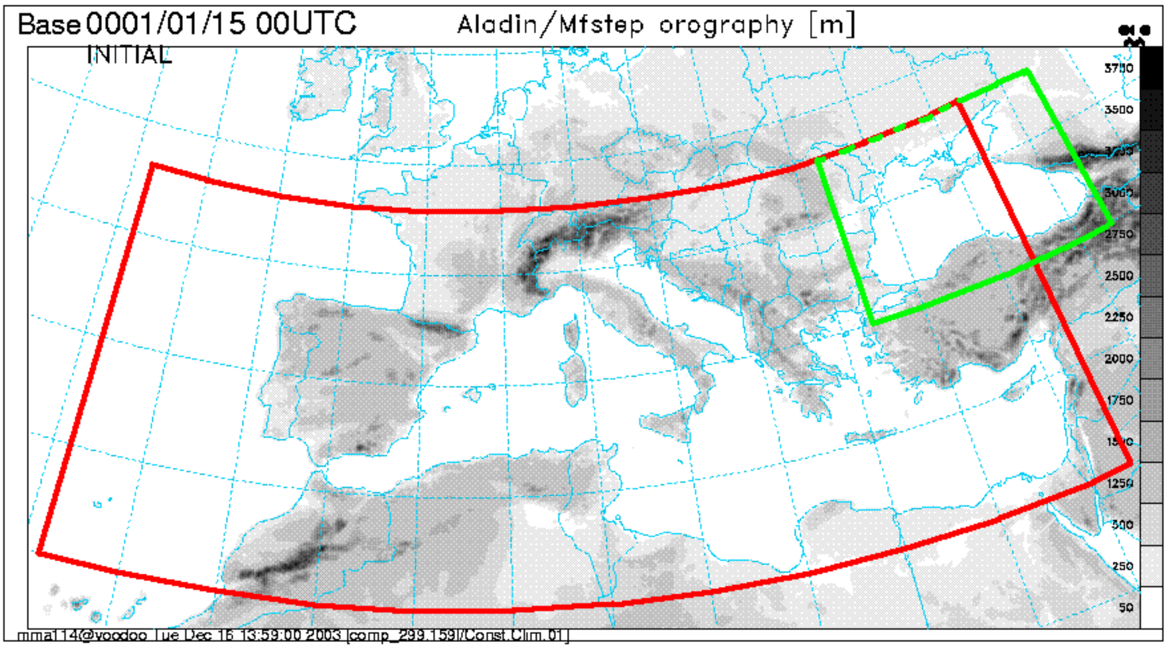

Figure 1: The Aladin/Mfstep computational domain with the model orography, and two frames displaying two dissemination domains.

Initial and lateral boundary data: assimilation/production suite

The lateral boundary data for the Aladin/Mfstep model are provided by the global model Arpege/IFS of Meteo-France (AGCM2), with the horizontal resolution of 29 km and spectral elliptical truncation 71/39 on a ‘quadratic grid’ (this corresponds to average Arpege resolution over the Aladin/Mfstep domain). The update frequency of the boundary conditions is 3h. The transformation of these lateral boundary data to the target Aladin/Mfstep domain is done using standard procedure by running particular Aladin model configurations.
To obtain the initial data, Aladin/Mfstep is running in the permanent pseudo assimilation blending cycle coupled to 4DVAR of the global model Arpege. Blending is the method used to preserve both the high resolution features of the Aladin forecast and the recent information coming from the observations contained in the analysis of the driving model via combining (blending) those two fields (see WP10/D8 report for more details). The cycling is intermittent, with the update frequency every 6h. From each analysis a 6h forecast (with 3h coupling frequency) is produced to obtain the first guess for the next assimilation step. The assimilation cycle is always linked to late cut-off timings of the Arpege model.
In the production mode, the forecast is launched from the initial conditions provided by the assimilation cycle described above according the specifications of SVP and TOP. Each forecast is initialized using the incremental digital filter procedure.
The hourly data from both the assimilation and the production mode are now available for the ocean modelers.

Scientific developments

Several modifications of the reference version of the Aladin system running operationally at CHMI were tested in order to improve the model performance over the sea (which is not typical target area of the Aladin applications), with the emphasis on the surface fluxes and other near surface data which are the input for the ocean modelers. Substantial part of those tests was carried out on the so called ‘Black sea case’ (+48h forecast from 12/09/2003), when an intensive cyclogenesis occurred with the minimum value of the forecast mean sea level pressure 986hPa (Figure 2, top). This low pressure system was observed in reality, but its predicted minimum value was too deep. Therefore many tests were performed with the aim to improve this forecast by keeping the cyclone with more realistic pressure drop. The most important steps leading to the Aladin/Mfstep system improvement were:
introduction of a modified computation of the thermal roughness length over the sea
activation of an already existing ‘moist gustiness’ parameterization
tuning of the clouds parametrization scheme
Besides that, also the tuning of the blending parameters took place, introduction of several ’safety’ constants in physics and activations of other parametrizations proved to lead to improvements of the model performance. A simulation of the Black sea case storm obtained with the described tuning is shown on Figure 2, bottom picture, with more realistic low value of 993hPa. The satellite picture on Figure 3 documents that the simulated storm was really observed.
Final version of the tunings and modifications was also carefully tested in the parallel suite environment. This setup was then used for SVP production and also for the beginning of the TOP production.
New technique for selective Semi-Lagrangian horizontal diffusion (SLHD) was introduced into the Aladin/Mfstep system, as it was proved to reduce the spurious maritime cyclogeneses. It is expected to be activated in the Aladin/Mfstep once it is fully validated and tuned.
A few attempts were made to replace the envelope orography used by Aladin models with a ‘semi-envelope’ one and modify the drag and lift parametrizations to compensate this change. If satisfying results are obtained, this modification will also enter the Aladin/Mfstep environment.

An attention was paid to the improvement in the radiation scheme, mainly to its cost-effectiveness. The code reorganization was made to compute more exactly thermal radiative fluxes and to save CPU while obtaining the clear sky radiative fluxes. An example of the solar downward radiative fluxes is shown on Figure 4. Investigations are currently carried out to further improve and optimize the Aladin radiation scheme.

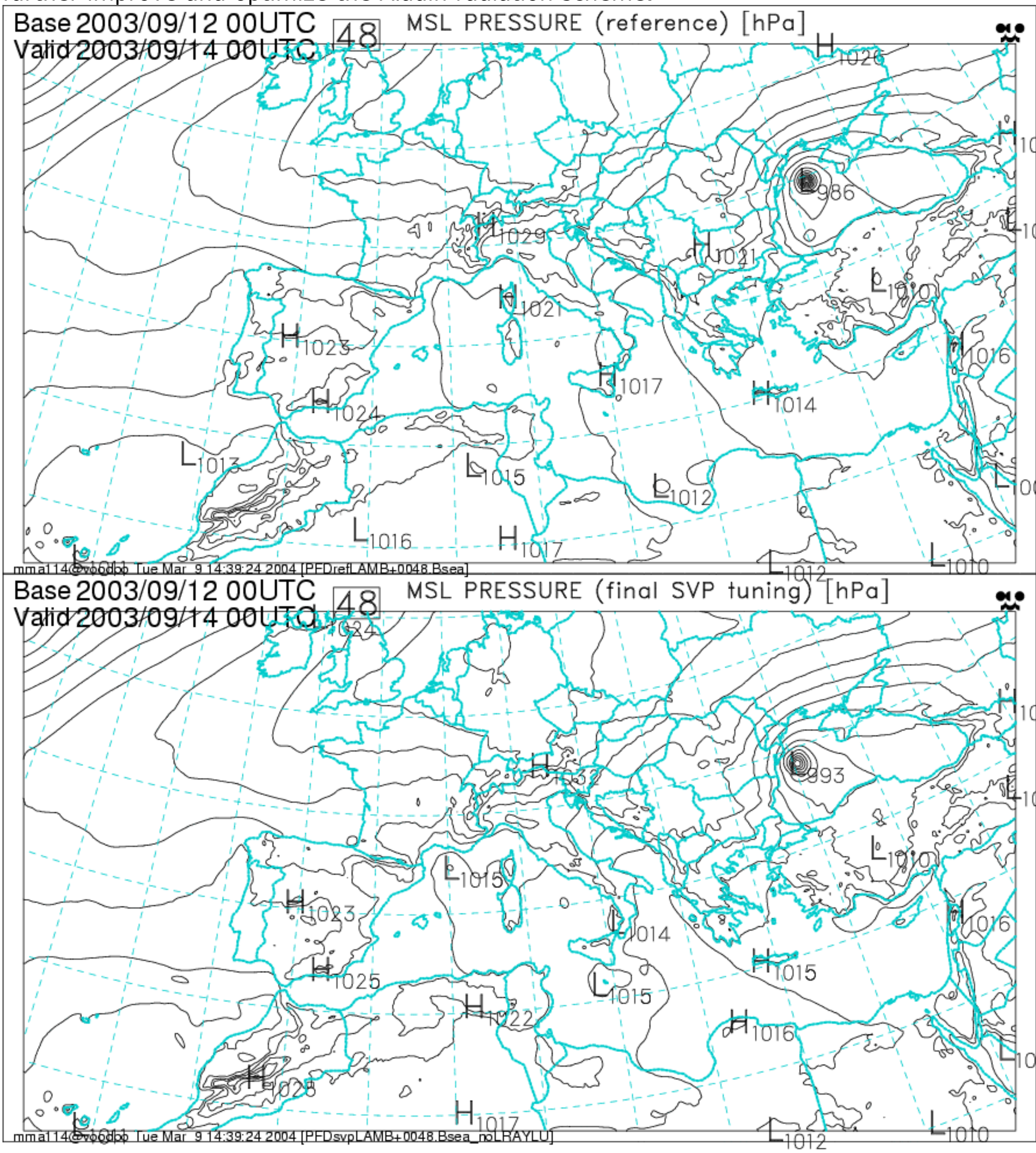

Figure 2: The Black sea case experiment. The forecast mean sea level pressure obtained with the reference system (top) and the final Aladin/Mfstep setup used in SVP and TOP (bottom).

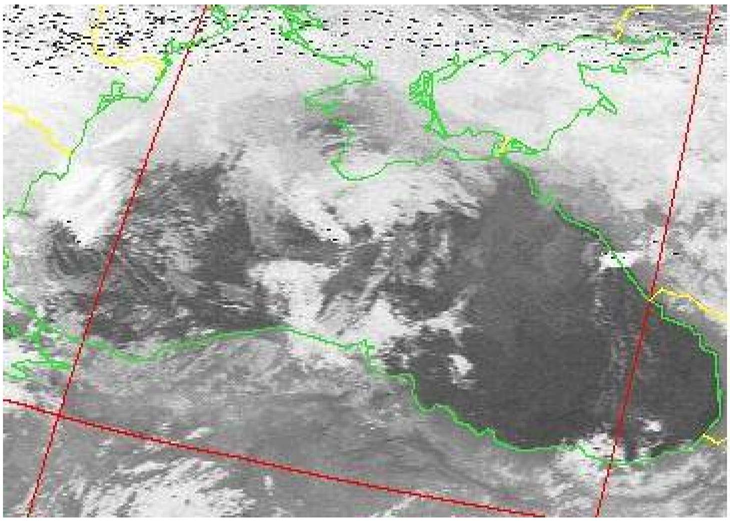

Figure 3: The satellite picture displaying the Black sea case storm: NOAA-17 IR image, 13.09.2003, 16.18UTC

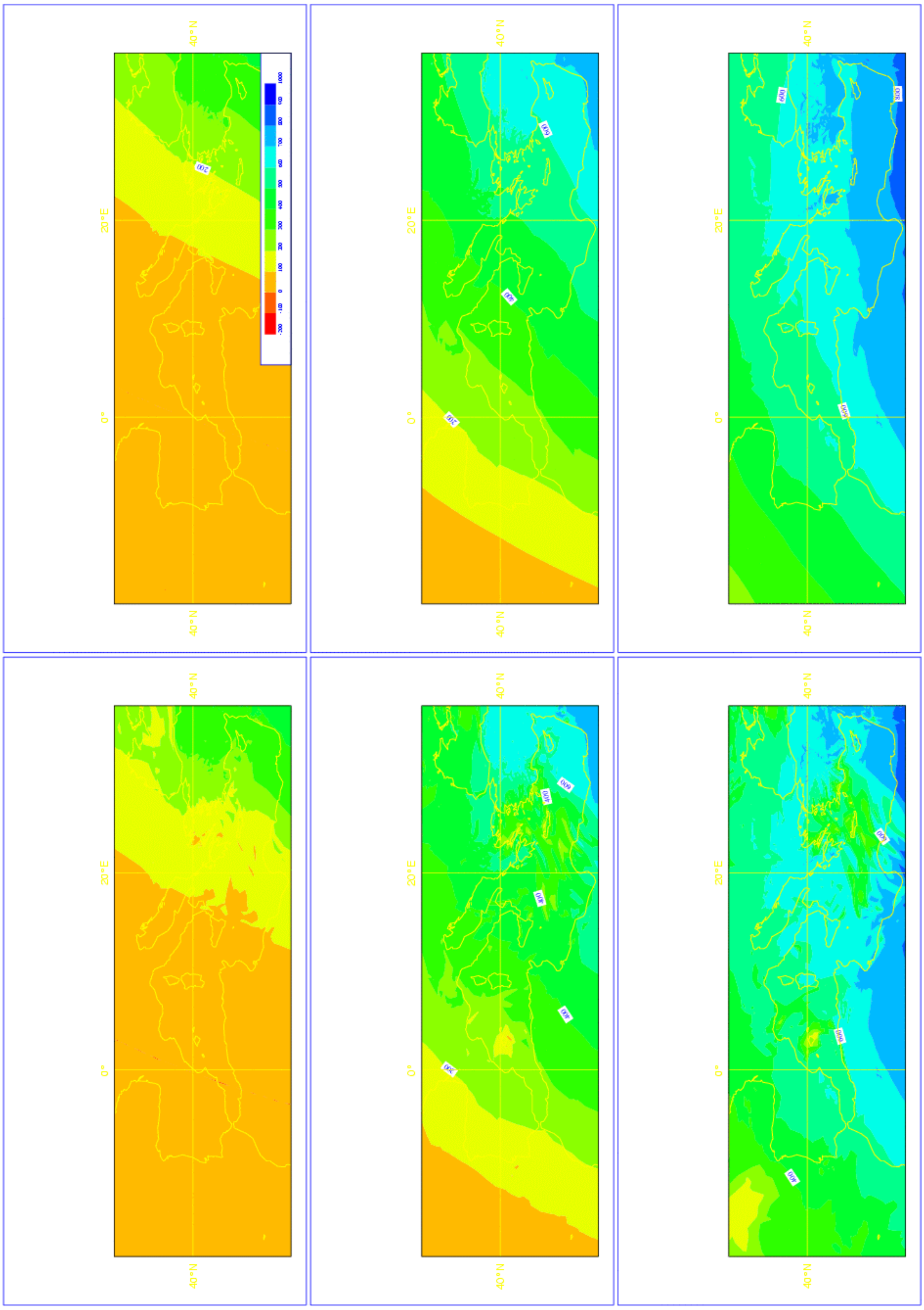

Figure 4: An example of the downward solar radiation flux [W/m2] from 17/02/2004 06 UTC forecast for +1h, +3h and +5h from top to bottom. The clear sky situation is on the right panel while the real one on the left.

Aladin/Mfstep products

The aim of the WP10 task is to provide the atmospheric data to ocean modelers. The list of the fields provided by Aladin/Mfstep is summarized in Table 1.

No.	MFSTEP field	units	GRIB ID
1	2m specific humidity	[kg/kg]	51
2	2m temperature	[K]	11
3	10m v-wind component	[m/s]	34
4	10m u-wind component	[m/s]	33
5	mean sea level pressure	[Pa]	2
6	evaporation	[kg/m2]	57
7	sensible heat flux	[W/m2]	122
8	latent heat flux	[W/m2]	121
9	land-sea mask	[0=sea, 1=land]	81
10	total accumulated precipitation	[kg/m2]	61
11	longwave down radiative flux	[W/m2]	153
12	clear sky longwave down radiative flux	[W/m2]	157
13	longwave up radiative flux	[W/m2]	151
14	clear sky longwave up radiative flux	[W/m2]	155
15	shortwave down radiative flux	[W/m2]	154
16	clear sky shortwave down radiative flux	[W/m2]	158
17	shortwave up radiative flux	[W/m2]	152
18	clear sky shortwave up radiative flux	[W/m2]	156
19	sea surface temperature	[K]	11
20	cloud coverage	[%]	71

Table 1: The list of Aladin/Mfstep surface fields

GRIB_ID follows the WMO standards except numbers 151-158 which are locally used for radiative flux components.

Radiative flux components are positive quantities, and the direction of the flux should be recognized by its name (up/down). Latent heat flux and sensible heat flux are calculated positive downward, i.e. their sign is mainly negative. The same remark is valid for evaporation. All fluxes except precipitation and evaporation are of instantaneous type. Precipitation and evaporation are cumulated within 1 hour interval, and they are expressed in [mm], i.e. [kg/m2]. The fresh water flux can be obtained as a sum of those two quantities.

Note, that at the forecast range +0h there are no fluxes available (products no. 9-20). However, the +6h forecast from the previous assimilation step can be used. For example, to obtain fluxes at 18 UTC on 03/01/2003 one should use the +6h forecast from 03/01/2003 12 UTC (instead of +0h forecast from 03/01/2003 18 UTC).

According to WP10 requirements, data are provided in regular lat/lon grid with horizontal resolution 0.1x0.1deg. Due to the Lambert projection it was not possible to cover whole area of interest; therefore two dissemination domains were prepared:

Mediterranean sea [-19W, 37E];[30N, 48N] => 561x181 points, abbreviated 'm'
Black sea [27E, 42E];[40N, 48N] => 151x81 points, abbreviated 'b'

These domains are shown on Figure 1 as red (Mediterranean sea) and green (Black sea) frames. Note that the Mediterranean sea dissemination domain covers the whole new OGCM domain so that one can test the usage of the fine mesh LAM1 atmospheric forcing to run OGCM model.

The data format is standard grib. The naming convention follows the WP10 proposal, slightly modified to mirror the above mentioned specifications:

MFSTEP_CHMIdm_HHDDMMYY_XXX.grb, where
d stays for domain (hence 'b' or 'm');
m stays for mode (hence 'a' for assimilation or 'p' for production);
HHDDMMYY denotes the starting forecast time (hour, day, month, year);
XXX is the validity of the forecast.

For example:

MFSTEP_CHMIma_00030103_000.grb

is the analysis ('+0h forecast') from the assimilation cycle, starting (and valid) at 03/01/2003 00 UTC, postprocessed to Mediterranean sea domain;

MFSTEP_CHMIma_00030103_004.grb

is the +4h forecast within the assimilation cycle, starting from 03/01/2003 00 UTC, valid at 03/01/2003 04 UTC, postprocessed to Mediterranean sea domain;

MFSTEP_CHMIbp_00030103_028.grb

is the +28h forecast in production mode, starting at 03/01/2003 00 UTC, valid at 04/01/2003 04 UTC, postprocessed to Black sea domain.

Results
Aladin/Mfstep version of Aladin limited area numerical weather prediction model has been established at Czech Hydrometeorological Institute in Prague in the frame of the Mfstep project Work Package 10, in order to provide the atmospheric forcing for ocean modeling community.

Deliverable state

Del Number	Description	State	Dissemination date
D03	Report (Note that after WP8910 Athens meeting the D03 as defined in the Dow becomes obsolete. It is replaced in fact by this scientific report on implementation of LAM1 within subtask 10125.)	completed	01-12-2003

Partner info			
N°	11	Acronym	IASA
Subtask info			
N°	10130	Title	PREPARATION OF LAM FOR THE EASTERN MEDITERRANEAN

Abstract

The nonhydrostatic version of the SKIRON/Eta modelling system was implemented in the Mediterranean and Black sea in order to produce high-resolution (~10km) weather hindcasts and forecasts during the SVP and the TOP. According to the Description of Work the SKIRON/Eta model was planned to provide meteorological forecasts in the Mediterranean region east of 18°E. However, IASA, Meteo-France and CHMI decided that both SKIRON/Eta and Aladin models will provide forecasts for the whole Mediterranean and Black sea regions. Sensitivity experiments using different domains showed the suitability of the chosen domain. IASA developed and tested the necessary algorithms for the pre-processing of the boundary conditions provided by Meteo-France, and for the production of graphics and the encoding of the model output in GRIB format. High resolution topography, vegetation, soil and SST data are utilized in the model runs. Finally, the whole modelling system, including the procedures for the dissemination of the output, was extensively tested in pseudo-operational mode runs.

Data and methods

1) Introduction

The SKIRON/Eta modelling system is based on the Eta/NCEP model and it has been developed to operate as fully automatic. The current version of the model is appropriately coded in order to run on any parallel computer platform utilizing any number of processors (Kallos et al. 1997). Dust and mercury cycle modules have been incorporated in the hydrostatic version (e.g. Kallos et al. 2001; Nickovic et al. 2001; Voudouri et al. 2004) A detailed description of its characteristics is to be found in Kallos (1997), Nickovic et al. (1998), Papadopoulos et al. (2002). The modeling system was extensively tested in pseudo-operational mode runs in the period before the start of the operational phase of the project.

2) Model geometry, dynamics and parameterizations

The model has several unique capabilities making it appropriate for regional/mesoscale simulations in areas with varying physiographic characteristics, such as the Mediterranean sea region. It has the unique capability to use either a "step-mountain" vertical coordinate (Mesinger 1984) or the customary pressure or sigma (or hybrid) coordinate. Moreover, a large number of parameterization schemes is included in the model in order to represent the various physical processes that cannot be modelled explicitly. These processes must be included if an accurate representation of the atmospheric flow is expected.

The main features of the system that was implemented in the Mediterranean region in the framework of MFSTEP project are described here:

The model variables are represented on the staggered Arakawa E-grid. It has been shown by Winninghoff (1968) and Arakawa and Lamb (1977) that various horizontal grids simulate differently large and synoptic scale atmospheric processes. It was demonstrated that the grids E and C (and also the B grid which is equivalent to E) have advantages relative to the A and D grids. The grid separation related to the E grid is avoided by the use of a special technique (Mesinger 1973; Janjic 1974, 1979).

For horizontal advection the cascade process of non-linear energy toward smaller scales is under control.

The "step-mountain" Eta coordinate is used in the vertical. It may be considered that the eta coordinate represents a more natural alternative to the widely used sigma system for ever-increasing horizontal and vertical model resolution, accompanied by a need to have more realistic model mountains. The schematic picture of the Eta coordinate mountains, as well as the distribution of the variables in the vertical is shown in Figure 1.

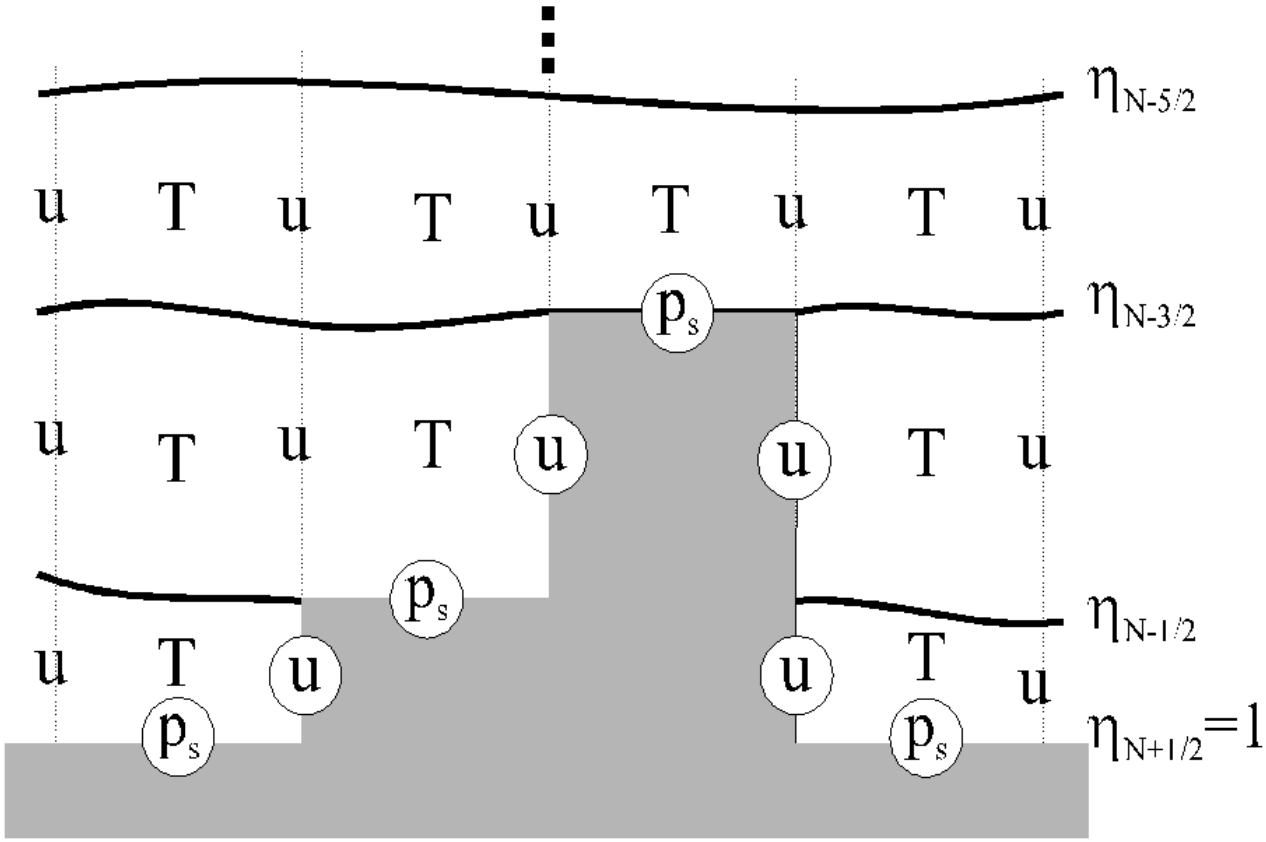

Figure 1. The eta vertical coordinate system and the distribution of the model variables in the vertical

The arithmetic solution of the set of equations is performed in a grid point model using a finite difference scheme.

A split-explicit scheme is used for time differencing. More specifically, a “forward-then-centered time” time differencing scheme is used for the horizontal advection. For the vertical advection of temperature, specific humidity, turbulent kinetic energy and horizontal momentum, the Euler-backward (Matsuno) scheme is used.

The model includes the option to use either the hydrostatic assumption or nonhydrostatic dynamics. In the framework of the MFSTEP project the model physics will include nonhydrostatic dynamics (Janjic et al. 2001). The nonhydrostatic model appears to be computationally robust at all resolutions and efficient in NWP applications. The use of nonhydrostatic dynamics is an important improvement especially for high-resolution simulations in which the non-hydrostatic processes may exert a significant influence on the meteorological fields. In high-resolution simulations the nonhydrostatic model is generally more robust than the hydrostatic one and produces smoother solutions

The boundary layer is parameterized using a 2.5 order closure scheme proposed by Mellor and Yamada (1982).

A 2nd order closure scheme proposed by Mellor and Yamada is used to parameterize the surface layer.
A viscous sublayer scheme is used over ground and water surfaces in order to improve the calculation of the surface fluxes. The method proposed by Zilitinkevich (1995) is used over ground points, specifying an effective roughness length as a function of the flow regime and of the grid-box orography variation. The viscous sublayer over water surfaces in the Skiron/Eta model is designed by matching the log profile of the considered variables with a separate viscous sublayer profile (Janjic 1994).
The surface processes are parameterized using the Oregon State University scheme (Mahrt and Pan 1984; Ek and Mahrt 1991). The soil temperature and moisture are calculated at six layers extending from the surface down to 255cm. A data assimilation scheme for soil temperature and soil wetness has been recently developed.
The parameterisation of the subgrid scale convective processes is allowed to use either the modified Betts-Miller-Janjic or the Kain-Fritsch approach. Both schemes take into account deep and shallow convection. In the framework of MFSTEP project, the model will be integrated using the Betts-Miller-Janjic convective parameterization which was extensively tested in pseudo-operational mode runs during the last months.
The large-scale cloud and precipitation parameterization is based on the scheme of Zhao and Carr (1997). In this scheme cloud water and ice are prognostically calculated in the stratiform clouds. Precipitation is diagnosed directly from the cloud water/ice content. Two types of precipitation, rain and snow, are calculated in the scheme. Evaporation of clouds and precipitation and snow melting below the freezing level are allowed by the model.
The radiative fluxes are calculated using the GFDL radiation scheme (e.g. Schwarzkopf and Fells 1991). Three radiatively active gases of the atmosphere (water vapour, carbon dioxide and ozone) are considered. The GFDL scheme takes into account the cloud information supplied by the parameterization of moist processes allowing random overlapping of clouds at various levels.

3) Model domain characteristics
The computational model domain covers the whole Mediterranean Region and part of Central Europe (Figure 2). Sensitivity experiments using different domains showed the suitability of the chosen domain. The integration time which is a very crucial parameter for the operational phase of MFSTEP was also considered in the choice of the domain. In the horizontal, a grid increment of 0.1 degrees is applied. According to the Description of Work the SKIRON/Eta model was planned to provide meteorological forecasts in the Mediterranean region east of 18°E. However, IASA, Meteo-France and CHMI decided that both SKIRON/Eta and Aladin models will provide forecasts for the whole Mediterranean and Black sea regions. Therefore the dissemination domain of SKIRON/Eta model extends from 29°N to 48°N and from 11°W to 42°E (Figure 2).

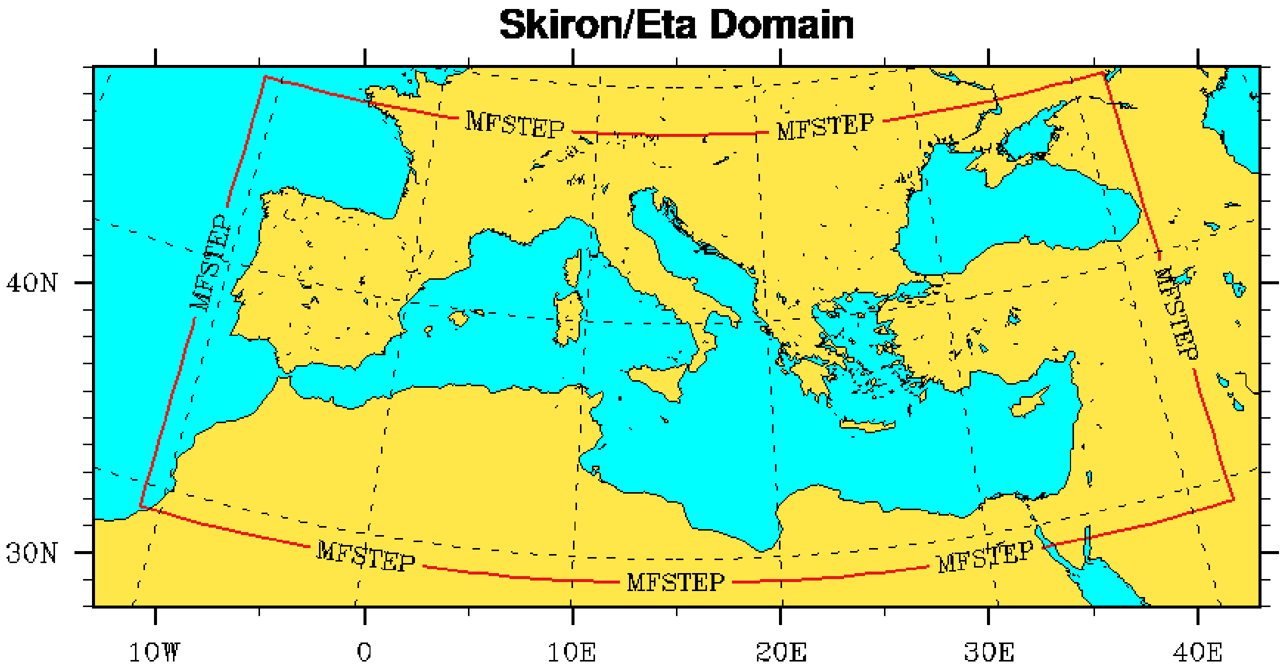

Figure 2. The computational domain of SKIRON/Eta model. The red frame encompasses the dissemination domain.

In the vertical direction the current configuration employs 38 levels stretching from the ground to the model top at 25 mb (corresponding approximately to 25 km) or optionally to 50 mb (~20 km). The large number of vertical levels is expected to provide a good vertical representation of the physical processes especially within the atmospheric boundary layer.

High resolution topography, vegetation and soil data are used. The topography and vegetation data are available from USGS with a resolution of 30x30 arc sec, with the later following the SiB classification (Dorman and Sellers 1989). For soil textural class the UNEP/FAO dataset (2x2 arc min) is used after its conversion from soil type to soil textural ZOBLER classes (Zobler 1986).

The model also allows the use of high resolution NCEP SST data of 0.5 degrees, high-resolution NESDIS snow and ice cover data and US Air Force snow depth analysis data. These products are available daily in standard WMO GRIB format. Thiebaux et al. (2003) showed that the use of the high resolution SSTs by ETA model resulted to improved forecasts of storm track and precipitation over Eastern US. The SKIRON/Eta modeling system has also been prepared to use alternatively the lower resolution (1°) NCEP SST dataset and the 0.5° ECMWF SSTs. Sensitivity tests performed by the SKIRON/Eta model during the pseudo-operational mode runs indicated the superiority of the 0.5° SSTs.

4) Initial and Boundary conditions

During TOP, SKIRON/Eta model produces 120-hour forecasts initialized every Wednesday from the 0000 UTC ARPEGE analyses. The initialization of the soil moisture and temperature is performed using the 24-hour forecast from the previous day cycle. The lateral boundary conditions are based on the ARPEGE forecasts and they are updated every 3 hours. The ARPEGE analyses and forecasts used for initial and lateral boundary conditions are provided by Meteo-France at a horizontal resolution of 0.25x0.25 degrees. The fine resolution of the initial data is expected to be an important factor of these forecasts because it reduces the spin-up time of the LAMs.

IASA has produced special algorithms to pre-process the boundary conditions provided by Meteo-France. The boundary conditions which are used for the daily SKIRON/Eta forecasts (except from Wednesday) are provided in a frame based format. Figure 3 illustrates the 96-hour forecast of geopotential height (gpm) from 0000UTC on 6/10/03 provided by ARPEGE in frame format. These algorithms have been tested extensively since it is well known that the boundary conditions are very important in limited area modelling.

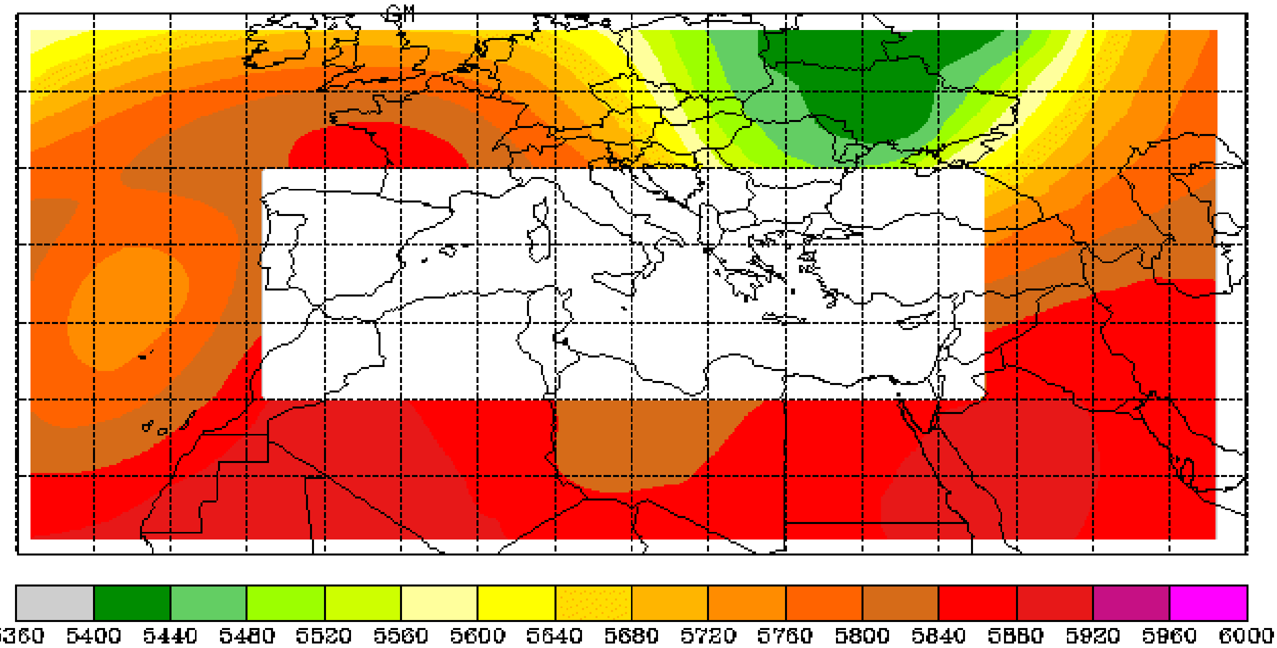

Figure 3. 96-hour forecast of geopotential height (gpm) provided by ARPEGE model in Frame format. Initial time: 0000 UTC, 6/10/03.

5) Model Output
IASA has developed and tested the necessary post-processors for the encoding of the model output in GRIB format and the production of graphics in PNG (Portable Network Graphics) format. The meteorological fields which are available to the project partners in the dissemination domain and will be used to force the ocean models include the u and v component of the 10m. wind, the 2m. air temperature, the 2m. specific humidity, the cloud fraction, the mean sea-level pressure, the total accumulated precipitation, the downward/upward shortwave and longwave radiative fluxes, the evaporation, the surface latent and sensible heat flux, the land-sea mask and the sea-surface temperature. These fields are available in hourly intervals at a horizontal grid of 0.1x0.1 degrees.

6) Final remarks
The high-resolution SKIRON/Eta modelling system runs parallel, at the computer facilities of IASA, in order to achieve the highest performance. Specifically, a cluster of ten (10) dual-CPU nodes based on ATHLON-1900 processors is used and it has been configured in order to handle large data storage, namely a RAID 4:1 system handling approximately 350 GBYTE of data on line. The system is connected to a high-speed network (1 Gbit/sec the slowest network section) and it is exclusively available for the scopes of the project.

Results

The SKIRON/Eta modelling system provides operational forecasts to the MFSTEP ocean modellers since December 2003. The performance of the modelling system in predicting deep Mediterranean cyclones will be illustrated in this section.

At the end of January 2004 the Eastern Mediterranean was affected by an intense frontal cyclone that was associated with bad weather and strong winds. At 1200 UTC on 21 January a multiple-center low-pressure area covered Central and Eastern Mediterranean (Figure 4a from UKMO forecast) and the minimum mean sea-level pressure in the area was 999 hPa. During the following day, a deep cyclone formed rapidly and at 0600 UTC it was located in the Aegean Sea exhibiting a minimum pressure of 981 hPa (Figure 4b). Bad weather, heavy snowfall, thunderstorm activity and gale force winds were observed in Greece, Turkey and Cyprus. A minimum pressure of 977 hPa was observed at the island of Samos at 1220 UTC, while maximum 10m. winds of 43 knots (~ 22 m/s) with gusts up to 67 knots were recorded at Mykonos island. Rapidly developing extra-tropical cyclones that deepen at least 1 hPa/hour for 24 hours are called "bombs" (Sanders and Gyakum 1980). This cyclone exhibited the characteristics of "bomb" formation and it provided an interesting case study for model validation.

The operational SKIRON/Eta forecast that was initialised at 0000 UTC on 21 January 2004 represented the formation and the explosive deepening of the above cyclone. Figure 5 shows that the model predicted the mean sea-level pressure to drop rapidly from 1200 UTC on 21 January to 1200 UTC on 22 January, in agreement with the UKMO analyses. Preliminary analysis indicated that the minimum predicted pressure was about 980 hPa at the island of Samos. Bad weather, heavy precipitation and gale force winds were also predicted by the model in the whole Eastern Mediterranean basin. Maximum winds of 24-26 m/s (Figure 6a) and latent heat fluxes in excess of 600 W/m^2 were predicted in the basin.

In conclusion, the model represented successfully the formation, the explosive deepening and the track of the "bomb"-like cyclone that occurred in the Mediterranean in January 2004. These preliminary results clearly indicate that the SKIRON/Eta modelling system is a valuable tool of MFSTEP project able to predict rapidly developing synoptic-scale systems.

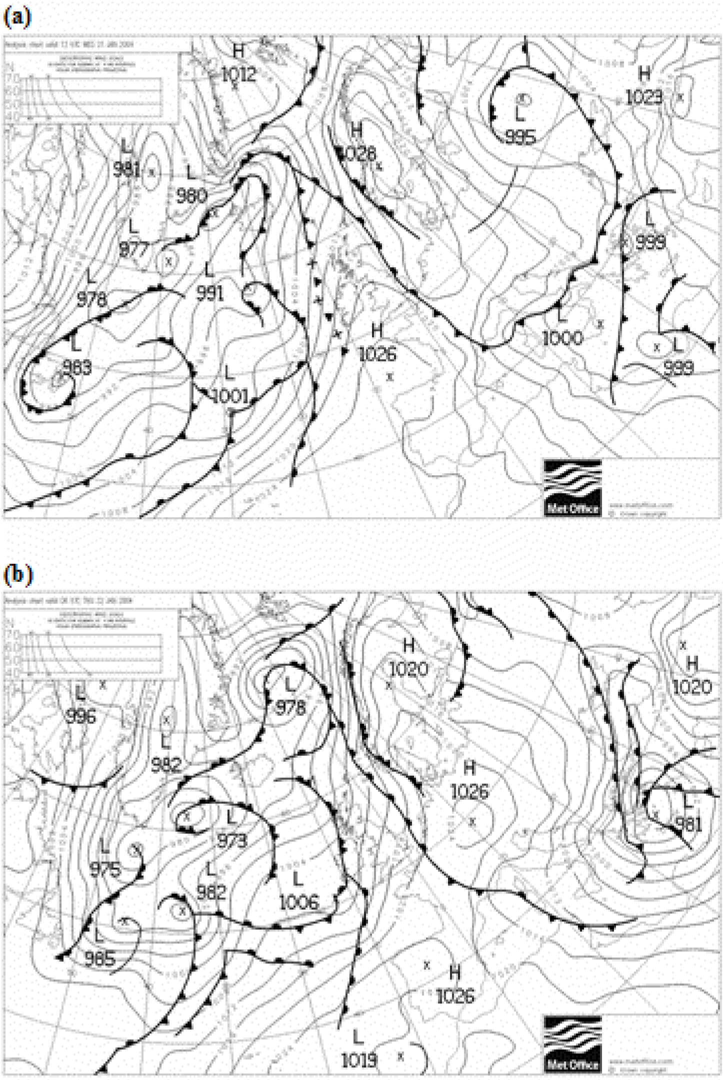

Figure 4. The UKMO mean sea-level pressure analyses at (a) 1200 UTC, 21/01/04 and (b) 0600 UTC, 22/01/04. Contour increment:4 hPa

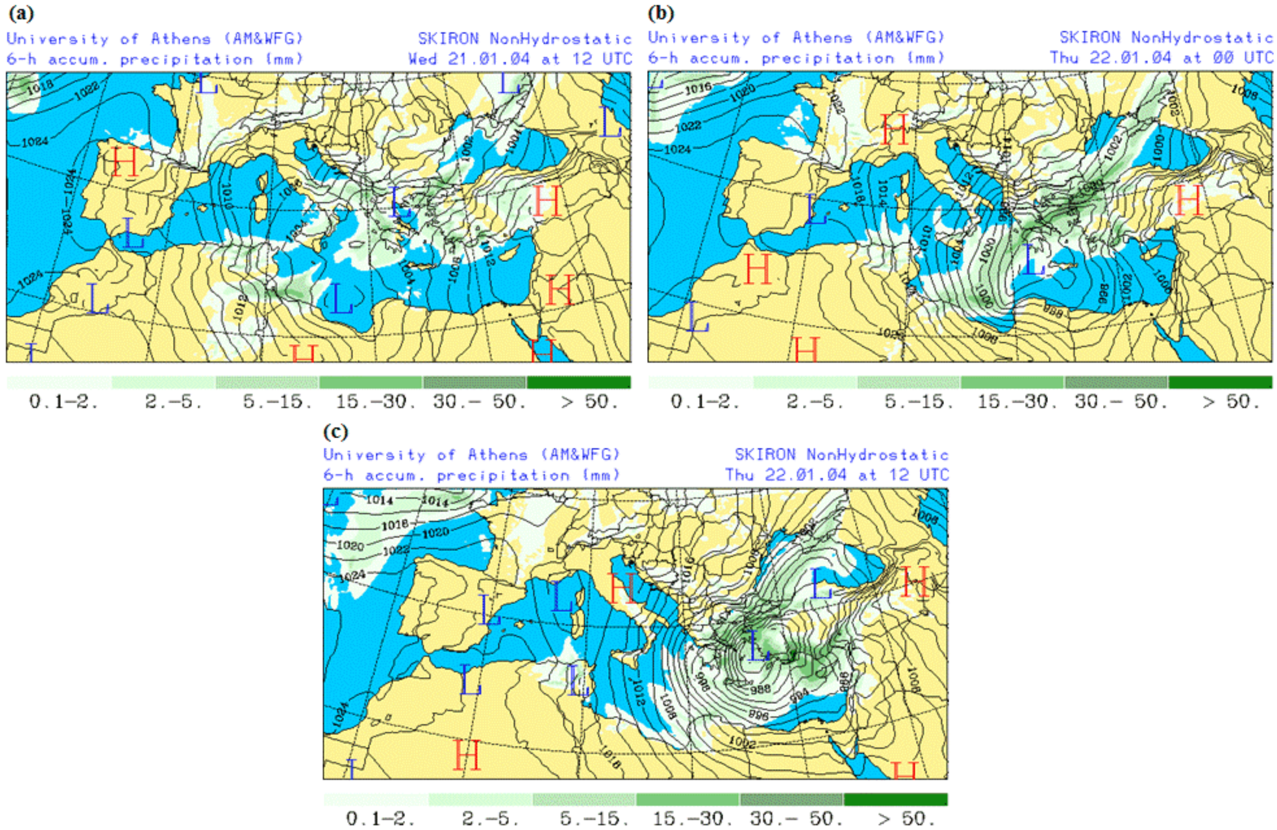

Figure 5. 6-hourly total accumulated precipitation and mean sea-level pressure at a) T+12, b) T+24 and c) T+36. Initial time: 0000UTC, 21/01/04. Contour increment: 2 hPa. The colour scale corresponds to the accumulated precipitation amount (in mm).

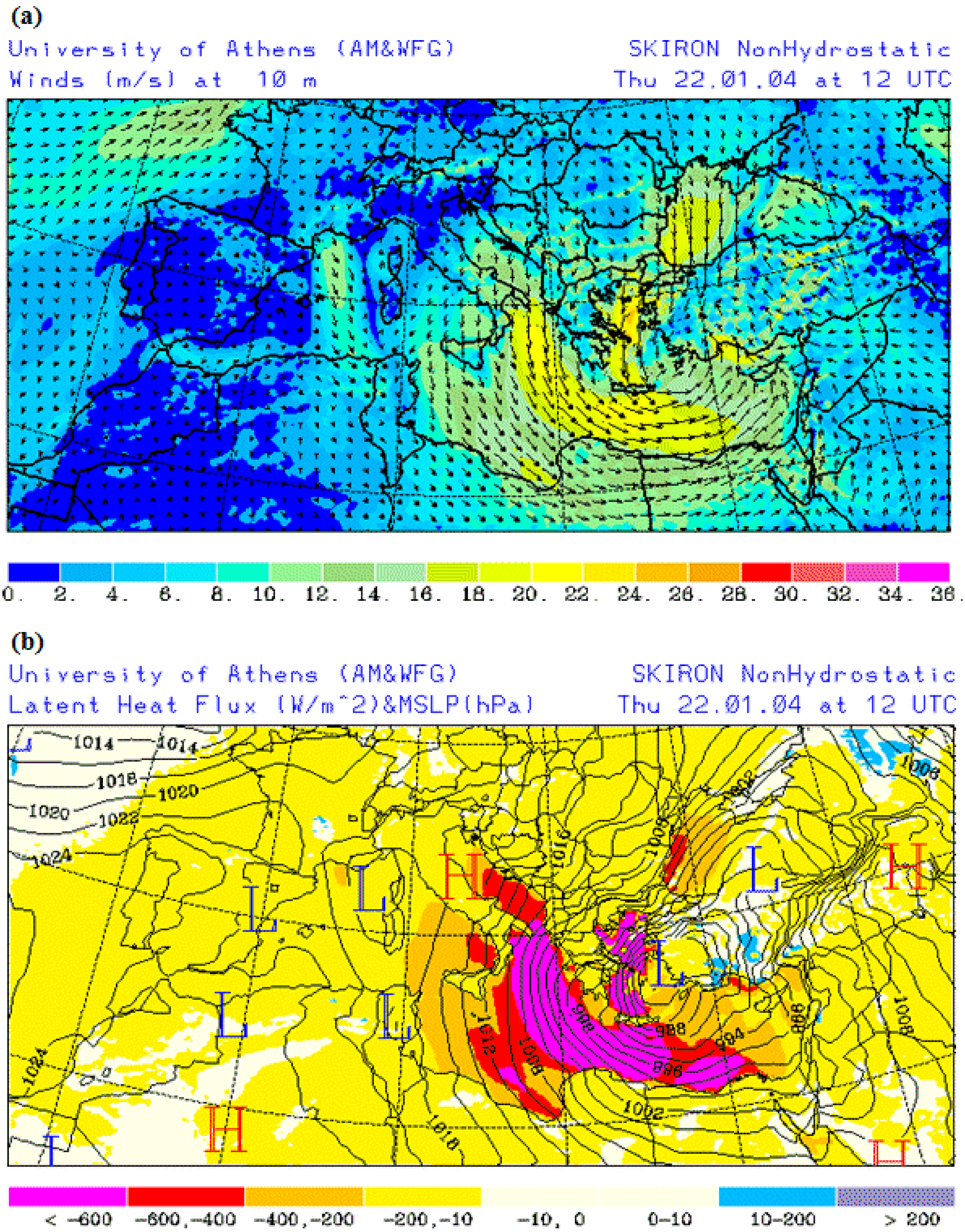

Figure 6. Horizontal sections of a) 10m. wind speed and direction and b) surface latent heat fluxes at T+36. Initial time: 0000UTC, 21/01/04. The colour scale corresponds to a) the 10m. wind speed (m/s and b) the latent heat fluxes (W/m^2).

References

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Deliverable state

Del Number	Description	State	Dissemination date
D4	Prototype - Software	Completed	30/11/03

Partner info			
N°	11	Acronym	IASA
Subtask info			
N°	10140	Title	NRT LAM forcing dissemination for TOP forecasts

Abstract

In the operational period of MFSTEP, IASA utilizes the nonhydrostatic SKIRON/Eta modelling system to provide high resolution (~10km) forecasts. 120-hour forecasts are produced operationally every Wednesday using the ARPEGE fields as initial and lateral boundary conditions. The model outputs become available to the project partners as raw data in GRIB format through the IASA ftp server and the WP10 webpage. Moreover, they are available to the general public as graphics in PNG (Portable Network Graphics) format.

Data and methods

In the framework of the Targeted Operational Period of MFSTEP project IASA utilizes the nonhydrostatic SKIRON/Eta modelling system at high-resolution (0.1 x 0.1 degrees). 120-hour forecasts are produced operationally once every week (on Wednesday) utilizing the 0000 UTC cycle ARPEGE fields as initial and lateral boundary conditions. Special algorithms have been installed in order to download the ARPEGE fields from the database of Meteo-France on an operational basis.

The computational domain is the full model domain covering the whole Mediterranean region and part of Central Europe. According to the Description of Work the SKIRON/Eta model was planned to provide meteorological forecasts in the Mediterranean region east of 18°E. In the beginning of the TOP period, IASA, Meteo-France and CHMI decided that both SKIRON/Eta and Aladin models will provide forecasts for the whole Mediterranean and Black sea regions. Therefore the dissemination domain of SKIRON/Eta model extends from 29°N to 48°N and from 11°W to 42°E.

The meteorological fields that become available to the project partners in the extended domain in order to force the ocean models are the:

Meteorological Variables	GRIB Code
u component of the 10m wind (m/s)	33
v component of the 10m wind (m/s)	34
2m Air temperature (ºK)	11
2m specific humidity (kg/kg)	51
cloud fraction (%)	71
mean sea-level pressure (Pa)	2
accumulated precipitation (kg/m^2)	61
downward shortwave radiation flux (W/m^2)	204
upward shortwave radiation flux (W/m^2)	211
downward longwave radiation flux (W/m^2)	205
upward longwave radiation flux (W/m^2)	212
Evaporation (Kg/m^2)	57
surface latent heat flux (W/m^2)	121
surface sensible heat flux (W/m^2)	122
land-sea mask (land=1, sea=0)	81
sea-surface temperature (ºK) (only analysis)	11

Table 1. Description of the included fields in the IASA GRIB encoded files.

These fields become available every hour up to 120 hours in regular latitude-longitude format (0.1x0.1 degrees). The accumulated precipitation is also accumulated in hourly increments. The SST field should be used in combination with the land-sea mask field (code 81) because it is not valid over the land.

The IASA/AM&WF group makes the model output available through the WP10 webpage (http://forecast.uoa.gr/mfstep/) and through the IASA ftp server (ftp.mg.uoa.gr), as soon as the model integration is completed. The model outputs are disseminated to the general public as graphics in PNG (Portable Network Graphics) format for the full computational domain. They can be accessed through the "Forecasting Operations" option of the MFSTEP-WP10 webpage. On the other hand, the raw data become available only to the project partners in GRIB format in the dissemination domain. Standard GRIB encoding for the model output has been adopted (Table 1).

IASA has setup an ftp server for the dissemination of the SKIRON/Eta output. Its address is:
ftp.mg.uoa.gr (IP: 195.134.91.103)
and the interested partners can be provided with a username and a password on request. Moreover, this server will be the backup ftp server for the dissemination of the operational Aladin/MFSTEP forecasts.

The filename convention of the IASA output files is:
MFSTEP_IASA_TTDDMMYY_XXX.grb
where TT, DD, MM and YY are the time, date, month and year (respectively) of the initial time and XXX is the forecast time (in hours). All the forecasts of IASA are archived. The partners can download all the TOP forecasts since December 2003 by using the provided username and password. Alternatively, the GRIB-files can be accessed through the MFSTEP-WP10 web page by clicking on the option "On-line Data" and using the provided login and password.

Results

The SKIRON/Eta modelling system provides operational forecasts to the MFSTEP ocean modellers since December 2003. Statistical evaluation of the model performance will be made in subtask 10510 using the SVP hindcasts. Preliminary subjective analysis of the operational forecasts indicated the good quality, and therefore the usefulness of the model output.

Deliverable state

Del Number	Description	State	Dissemination date
D05	NRT LAM Data Set	Completed	30/11/03

Partner info			
N°	20	Acronym	CHMI
Subtask info			
N°	10140	Title	NRT LAM forcing for TOP forecasts

Abstract
The Aladin/Mfstep (LAM1) model is running in order to produce the atmospheric forcing data in the frame of the Target Operational Period.

Data and methods

Aladin/Mfstep pre-TOP assimilation has started on the 2nd of February 2004 with data computed back from the 1st of February 2004. The production, i.e. the +120h forecasts every Wednesday 00 UTC (where lateral boundary data are from Arpege forecast based on its late cut-off analysis) has started on the 4th of February 2004.
Comparing to the SVP data preparation, some adjustments and optimization of the data production took place.
All TOP data (hourly outputs from assimilation and production suites) are uploaded to the ftp server of CHMI (ftp.chmi.cz). Thanks to kind offer of INGV in Bologna, the Aladin/Mfstep TOP data are also uploaded to data.bo.ingv.it server.
The approximate timing is:

NT	last LBC available	last grib available
00 UTC	9:15	10:15
06 UTC	14:00	16:15
12 UTC	21:15	22:15
18 UTC	2:00 next day	4:15 (next day)

However, the timing is different on Wednesdays, when the main +120h forecast is run. The last LBC (lateral boundary coupling) file for the forecast is available at approximately 12:30 UTC and the last grib file around 20:15 UTC. The availability of the grib data from the assimilation cycle on Wednesday is thus shifted.
Longer delays at 06 and 18 NT compared to 00 and 12 UTC runs are caused by the CHMI operational suite. This is based on early cut-offs at 12 NT and 00 NT, which are coming just after late cut-offs of 06 NT and 18 NT. The CHMI operational suite starts immediately after its input files are available, and has the highest priority on the CHMI NEC/SX6 computer. However, in the near future the Aladin/Mfstep suite shall be fully integrated into the Scheduler and Monitoring System of CHMI, therefore the availability of the Mfstep products shall significantly improve in terms of the timing for TOP purposes.

Results

The Aladin/Mfstep system has been setup and is permanently running since February the 2nd 2004 in order to provide data to the ocean modellers in the frame of the Target Operational Period (TOP). These TOP data both in assimilation and production mode are now on-line available to project partners.
The Aladin/Mfstep system can still evolve, as indicated in the 10125 subtask report, within the pre-TOP phase, but with the TOP official start on 01-09-2004 its development will be frozen.

Deliverable state

Del Number	Description	State	Dissemination date
D05	NRT LAM Data Set	Completed	30/11/03

Partner info			
N°	17	Acronym	MF
Subtask info			
N°	10140	Title	NRT LAM forcing for TOP forecasts

Abstract

Following the decisions made at the WP10 meeting in Athens, Météo-France is not any more responsible for the production (and harmonization) of LAM forecasts for the Western (and Central) Mediterranean basins, but for the whole production of near real time Initial- (IBC) and Lateral Boundary Conditions (LBC), on domains encompassing the OGCM one, and for both IASA and CHMI. The following has be tested on the SVP period of January 2003 in order to be then applied for pre-TOP and TOP routine production:

- integrate in Météo-France operational schedule a 120h forecast (from the long-cut-off data assimilation cycle) every Wednesday for the 00 UTC network;
- create LBC files (with a 3h our frequency) for IASA and CHMI on the said additional weekly run, as well as from the full week data assimilation cycle leading to this forecast;
- create LBC files for IASA on the daily (short-cut-off) operational 72h forecast run.

All this complex schedule has been made possible by the flexibility and comprehensive character of the so-called FullPOS software described in the next paragraph.

Data and methods

FullPOS is a powerful and sophisticated post-processing package. It is intended to be used for operation and research as well. FullPOS has two main parts: the vertical interpolations, then the horizontal interpolations. In between, a spectral treatment is sometimes possible for the dynamic fields.

FullPOS is a post-processing package containing many features. The following is just a small list of the main available features:

1) Multiple fields from the dynamics, the physics, the cumulated fluxes or the instantaneous fluxes
2) post-processing available on any pressure level, height (above output orography) level, potential vorticity level, potential temperature level or model level
3) Multiple latitudes X longitudes output sub-domains, or one Gaussian grid with any definition, or one grid of kind 'ALADIN', with any definition
4) Multiple possible optimisations of the memory or the CPU time used, through specific I/O schemes, vectorisation depth, distribution and various other segmentations.
5) Possible spectral treatment for all the fields of a given post-processing level type
6) Customization of the names of the post-processed fields
7) Support for computing a few other fields without diving deeply into the code of FullPOS
8) Ability to perform post-processing in-line (i.e.: during the model integration) or off-line (out of the model integration)
9) Ability to make ARPEGE or ALADIN history files, starting from a file ARPEGE or a file ALADIN (processes "927", "E927" and "EE927")

FullPOS is a non-independent software: it is designed to serve specifically the ARPEGE/ALADIN post-processing. To get a post-processing fully consistent with the model itself, FullPOS software has been completely embedded inside the ARPEGE/ALADIN software, in order that it can (and it should!) be re-used by model operators. The reliability of this concept has been ensured by the existence of a previous internal post-processing software (currently pointed out

by the name of its leading subroutine: POS). However the target of this previous internal software was limited to vertical pressure interpolations for a few specific fields to be written out as spherical harmonics, while FullPOS is designed to be a comprehensive post-processing tool.
FullPOS is also designed to serve both operations (which implies: high efficiency to be run in real time situation) and research (which means: the ability to process various elaborated fields on various grids and vertical levels).
This section will list the processes that have taken part in the elaboration of FullPOS. Presented prior to the architecture of the software, it should help understanding the conception of the code.
Dynamical fields should be post-process able on pressure levels (P), potential vorticity levels (P_v), isentropic levels, eta levels including other definitions than the model originating eta levels, and on height levels above a given orography (z).
Fields post-processed on P, P_v should be interpolated vertically first, then horizontally. In between, it should be possible (as an option) to fit the fields in spectral space (to remove the numerical noise induced by the vertical interpolations). For a few specific fields (like geopotential, medium sea-level pressure, ...) for which the formulation of vertical interpolation induces potential inconsistencies, a filter in spectral space should be optionally performed.
Fields post-processed on eta and z levels should respect the profile of the boundary layer; therefore they should be interpolated horizontally first, then re-adjusted with respect to the orography of the target grid.
To ensure the inter-consistency of fields interpolated on eta or z levels, only the model primitive variables (U, V, T, q, P_s currently) should be horizontally interpolated: the other fields should be recomputed from the interpolated model primitive variables.
Fields on horizontal surfaces should be homogenous; in other words the small-scale information should not pollute the interpretation of the output fields. This means that the fields which are composed of derivatives (like vorticity, divergence, vertical velocity as the integral of the divergence, but also any field on P_v levels) should be filtered in a spectral space of homogeneous resolution. The intensity of this filter should depend of the output grid resolution.
Physical fields from the model, including cumulated fluxes and instantaneous diagnostics, should be post-process able: their interpolations require often specific treatments, like the land/sea aspect (only points of the same nature should serve the interpolations), the control of the validity domain for the output values (for instance: the interpolated land/sea mask should be either 0. or 1.), or the interdependencies of the post-processed physical fields (for instance: deep soil temperature should be interpolated as its anomaly with respect to surface temperature, which implies to interpolate surface temperature prior to deep soil temperature).
It should be possible to use climatology data in order to interpolate with a better accuracy a few surface fields; instead of a straightforward interpolation, we would interpolate the anomaly of a field with respect to the climatology, or even: we would impose the whole climatology field if it is a constant field (land-sea mask for instance).
In case of grid-point outputs on a complete ALADIN grid, the extension zone should be computed as well, taking into account the realism of the physical fields.
In the initial design, horizontal interpolations had to be quadratic exclusively.
Wind-related fields (like vorticity, divergence, etc) should be computed from the wind components so that all these fields are consistent.
Beside the scientific aspects, various technical aims have been achieved:
It should be possible to post-process during the model direct integration (''in-line post-processing'') as well as after (''off-line post-processing''), both solution giving the same results. This implies that FullPOS should not be a specific ARPEGE/ALADIN configuration but a package which could be called inside the direct model temporal loop, and that the packing of fields in history files should be considered.

FullPOS should benefit, as the model does, from the (super)computer hardware architecture, that is: the memory distribution today and probably OPEN-MP tomorrow.
FullPOS should be cheap.
FullPOS should be modular and should not spread itself all over the code FullPOS users interface should be ergonomic. This should not mean that the users interface should be restricted to a limited number of namelists parameters, but rather that the namelists should be easy to set, with meaningful parameters.
FullPOS should stick to the ARPEGE/ALADIN interfaces standards: namelists parameters for the users interface and ARPEGE/ALADIN files for the I/O data.
The list of post-processing fields, levels and horizontal domains per post-processing time range should be flexible.
The horizontal output format has been restricted to: either one Gaussian grid, or one ALADIN grid, or a set of LATLON grids, or one definition of spectral coefficients.
One should be able to pack each post-processing field on a tunable specific number of bits.

Results

The following schedule was reached for all associated tasks to this item 10140:
- Météo-France: SVP data ready 20/11/03 and pre-TOP running from 3/12/03 onwards;
- IASA: SVP production ready on 3/02/04 and pre-TOP running from 17/12/03 onwards;
- CHMI: SVP production ready on 22/12/03 and pre-TOP running from 2/02/04 onwards.

Deliverable state

Del Number	Description	State	Dissemination date
D5	NRT LAM surface data set.	Completed	3/02/04

Partner info			
N°	11	Acronym	IASA
Subtask info			
N°	10150	Title	LAM fields for validation studies in SVP

Abstract

In the framework of the SVP of WP10 the atmospheric limited area models (Skiron/Eta and Aladin) produced 72-hour hindcasts initialized from the daily 0000 UTC ARPEGE analyses of January 2003. The corresponding ARPEGE forecasts were used as lateral boundary conditions. 31 simulations are available for model inter-comparison and validation. In addition, there are products from Aladin assimilation cycle. Finally, the model intercomparison protocols were defined.

Data and methods

1) SVP atmospheric fields
In the framework of the SVP of WP10, the nonhydrostatic SKIRON/Eta and the Aladin models were integrated at high-resolution (0.1 x 0.1 degrees). 72-hour hindcasts were produced utilizing the 0000 UTC cycle ARPEGE fields of January 2003 as initial and lateral boundary conditions. The ARPEGE fields were provided by Meteo-France at a resolution of 0.25 x 0.25 degrees.

In SKIRON/Eta the initialization of the soil moisture and temperature was performed using the 24-hour forecast of the run of the previous day. In Aladin model the assimilation mode started one day prior to the SVP, i.e. 31/12/2002 00 UTC in order to avoid spin-up of the assimilation cycle. This was based on the late cut-off time of the 4DVAR data assimilation system of the global model ARPEGE. Every day at 00 UTC a +72h forecast has been run, where initial files were obtained from the Aladin/Mfstep assimilation cycle, and the lateral boundary data were provided by the early cut-off forecasts of the driving model ARPEGE.

The computational domain of both models covered the whole Mediterranean region and part of Central Europe (Figures 1, 2). Following the decisions made at the WP10 meeting in Athens, the subtask partners decided that both SKIRON/Eta and Aladin models will provide forecasts for the whole Mediterranean and Black sea regions. Therefore the dissemination domain of SKIRON/Eta model extends from 29°N to 48°N and from 11°W to 42°E (Figure 1). The Aladin raw data were post-processed separately on two domains (Mediterranean = 30°N-48°N, 19°W-37°E; Black-Sea = 40°N-48°N, 27°E-42°E; see Figure 2). These fields are available every hour from the initial time up to 72 hours at a horizontal grid of 0.1x0.1 degrees.

The SKIRON/Eta and ALADIN-MFSTEP meteorological fields that become available to the project partners (hourly) in GRIB format are the u and v component of the 10m. wind, the 2m. air temperature, the 2m. specific humidity, the cloud fraction, the mean sea-level pressure, the total accumulated precipitation, the downward/upward shortwave and longwave radiative fluxes, the evaporation, the surface latent and sensible heat flux, the land-sea mask and the sea-surface temperature. Moreover, ALADIN provides the same radiation fluxes but computed for a cloudless atmosphere. In addition to the required surface variables, the upper air fields of geopotential, temperature and wind components at 500 and 850 hPa every 6 hours were delivered for the purpose of the inter-comparison of the two LAM models used.

The hourly data both from assimilation (only for Aladin model) and forecast mode were made available to the project partners well in advance of the deadline of Deliverable 7. The SVP production and upload finished on 22/12/03 for Aladin and 03/02/04 for Skiron/Eta model.

The SVP GRIB files are made available to the MFSTEP partners through the WP10 webpage (http://forecast.uoa.gr/mfstep/) and through the IASA ftp server (ftp.mg.uoa.gr, IP: 195.134.91.103). The interested partners can be provided with a username and a password on request. The Aladin/Mfstep SVP data have been uploaded to IASA ftp server because of the limited capacity of CHMI Internet connection (2Mbits per second). They have been stored in the directory 'svp/Aladin' where a short 'readme' file is also at disposal. Similarly the Skiron/Eta SVP data have been stored in the directory 'svp/Skiron'. No download of SVP data from CHMI will be possible, but these data can be sent on DVD to interested partners if requested.

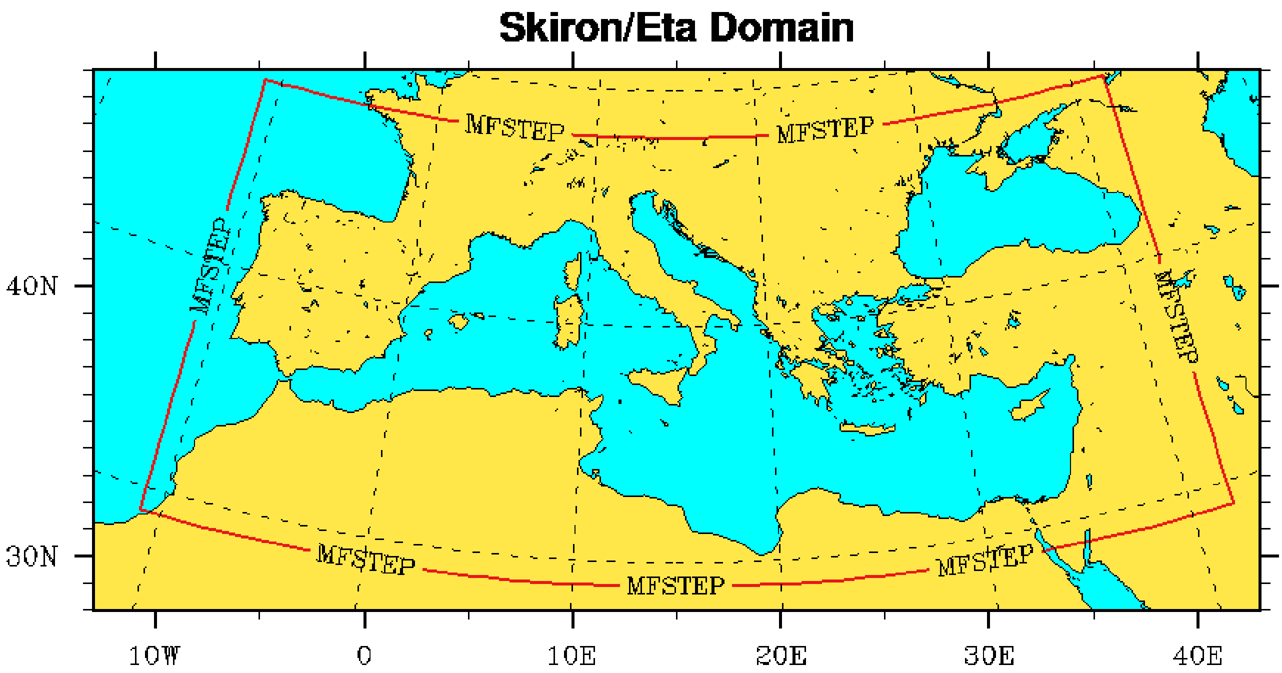

Figure 1. The computational and dissemination (framed) model domain of Skiron/Eta modelling system.

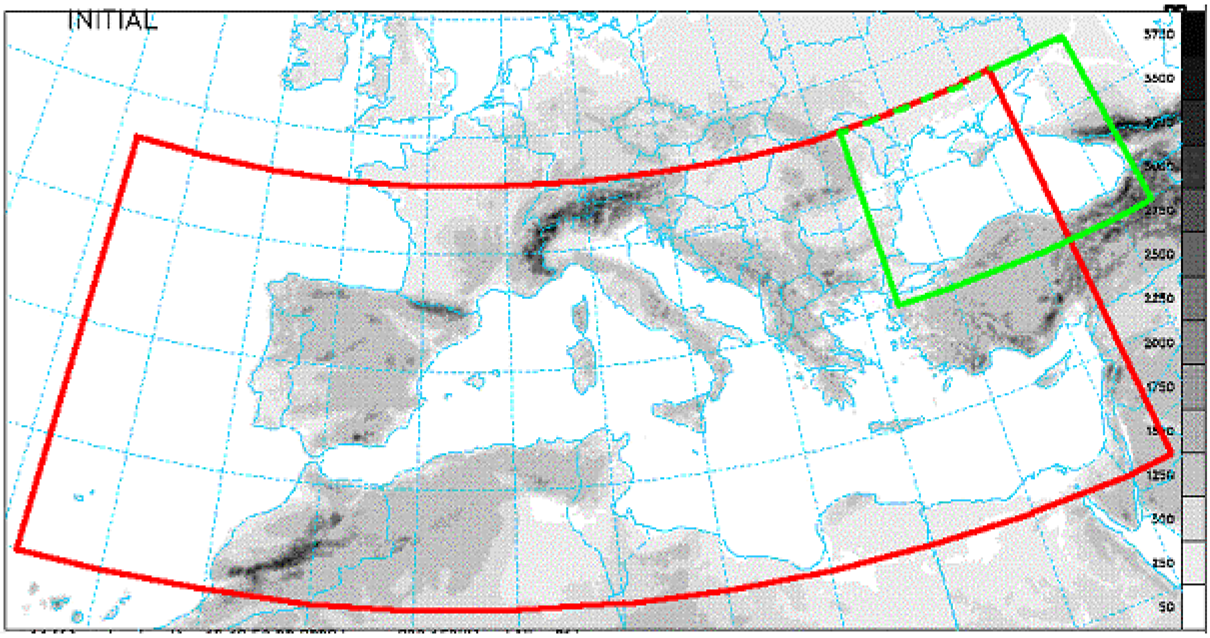

Figure 2. The computational domain of Aladin model and the associated orography. The two color frames encompass the dissemination domains of Meteo-France and CHMI

2) Intercomparison protocols

The atmospheric model inter-comparison and validation that will be performed during SVP is an important task of WP10. The atmospheric modelers will be able to identify and improve model uncertainties (related to the model setup, the pre or post-processing modules, the utilized surface characteristics etc.). It will also provide credibility to the meteorological fields that will be used operationally to force the ocean models.

The validation will be performed with the use of well-known and widely accepted statistical methods. The statistical tests will quantify the relationship between the forecast fields and the actual state of the atmosphere. In this task all available GTS observations (METAR and SYNOP) and the upper-air ARPEGE analyses will be used. This methodology allows the examination of the model performance in the whole period of the simulations, providing significant conclusions about the existence of systematic errors, the accuracy and the credibility of the model forecasts.

The statistical analysis exhibits some differences depending on whether the meteorological variables are discrete or continuous. Discrete variables are allowed to take on only a finite number of values, whereas continuous variables may take on any of the infinitely many real values within their range. The rainfall, snowfall and the cloud cover are considered to be discrete variables, while the temperature, the wind speed and the mean sea-level pressure are continuous variables. On the surface of the earth, the forecasts and the observations of continuous meteorological variables result from a finite number of discrete values. The statistical study of grid-point meteorological fields is also important. The surface pressure, the geopotential heights and the upper-air temperatures appear in the form of grid-point fields, with the use of objective analysis methods in International Meteorological Centers (ECMWF, NCEP, Meteo-France and others).

The partners have chosen a number of statistical methods that will provide a robust validation of the models. The use of wrong statistical methods may lead to misleading results. The statistical methods that will be used in order to validate the model performance are:

1) the bias, the root mean square error and optionally the frequency of forecast errors and the anomaly correlation for the continuous meteorological fields
2) the bias, the root mean square error and optionally the Equitable Threat Score for the discrete meteorological fields (e.g. Katsafados 2003; Wilks 1995).

A detailed description of the decided statistical methods appears in the report of the Deliverable 6. Finlly, the statistical validation and intercomparison of the model results will be performed in the following months under the scopes of subtask 10510.

Results

The set of selected surface and upper-air fields (of SKIRON/Eta and Aladin/Mfstep models) from the Scientific Validation Period of January 2003 have been delivered to the project partners for the purpose of model inter-comparison and validation.

References

Katsafados, P., 2003: Factors and parameterizations that determine the performance of limited area models in long-range weather forecasts. PhD Thesis, Dept. of Physics, Univ. of Athens, Athens, Greece. pp. 257 (in Greek).

Wilks, D.S., 1995: Statistical Methods in the Atmospheric Sciences, Academic Press NY, pp. 467.

Deliverable state

Del Number	Description	State	Dissemination date
D6	Report	Completed	31/08/03
D7	Dataset	Completed	29/02/04

Partner info			
N°	20	Acronym	CHMI
Subtask info			
N°	10150	Title	LAM fields for validation studies in SVP

Abstract

The Aladin/Mfstep (LAM1) model has been run in the hindcast mode for the purpose of the inter-comparison exercise within SVP.

Data and methods

After completing the setup and tuning of Aladin/Mfstep system the SVP (Scientific Validation Period: 01/01/2003-31/01/2003) hindcast data has been produced according to the WP10/D5 and WP10/D6 requirements.
The assimilation mode has started one day prior the SVP, i.e. 31/12/2002 00 UTC in order to avoid spin-up of the assimilation cycle. This was based on the late cut-off time of the 4DVAR data assimilation system of the global model Arpege. Every day at 00 UTC a +72h forecast has been run, where initial files were obtained from the Aladin/Mfstep assimilation cycle, and the lateral boundary data were provided by the early cut-off forecasts of the driving model Arpege.
The hourly data both from assimilation and forecast mode are now available to project partners. In addition to the surface variables required for TOP, the upper air fields of geopotential, temperature and wind components at 500 and 850hPa every 6h were delivered for the purpose of the inter-comparison of the two LAM models used. Due to the limited capacity of CHMI Internet connection (2Mbits per second), and thanks to kind offer of IASA to use their ftp server for Aladin data, the Aladin/Mfstep SVP data have been uploaded to IASA ftp server ftp.mg.uoa.gr. They are now stored in directory svp/Aladin where a short 'readme' file is also at disposal. No download of SVP data from CHMI will be possible, but these data can be sent on DVD to interested partners if requested.
The SVP production and upload were finished just before Xmas, on December 22nd 2003.

Results

The set of selected surface and upper-air fields of the Aladin/Mfstep model for the Scientific Validation Period of January 2003 have been delivered for the purpose of the models inter-comparison and validation by the end of December 2003 to project partners.

Deliverable state

Del Number	Description	State	Dissemination date
D6	Report	Completed	31/08/03
D7	Dataset	Completed	29/02/04

Partner info			
N°	11	Acronym	IASA
Subtask info			
N°	10160	Title	WEB SERVER FACILITY

Abstract

The subtask partners have setup the procedures in order to make the meteorological fields, produced during TOP and SVP, available to the ocean modelling community through their ftp servers. The protocols for the data exchange were defined and documented in the report of the deliverable D8. Moreover, IASA setup the web server of work-package 10. The web-page of WP10 provides an alternative link for online access to the SVP and TOP fields, graphical outputs of the IASA TOP forecasts, useful information about the partners, links to the deliverables of WP10 and documentation of the models employed in the various tasks of WP10.

Data and methods

In the framework of MFSTEP, IASA, Meteo-France and CHMI produce operationally 120-hour forecasts once every week (on Wednesday), utilizing the 0000 UTC cycle ARPEGE fields as initial and lateral boundary conditions. Moreover, they have already produced 72-hour hindcasts initialized from the daily 0000 UTC ARPEGE analyses of January 2003.

The model output to be produced during TOP and the archived SVP-WP10 meteorological fields will be disseminated through ftp procedures and the WP10 web-page. IASA has setup the necessary procedures to make the Skiron/Eta output available online, as soon as the model integration is completed. The address of the IASA ftp server, which is dedicated to the dissemination of the MFSTEP products, is ftp.mg.uoa.gr (IP: 195.134.91.103) and the interested partners can be provided with a username and password. All the SVP hindcasts and the operational Skiron/Eta forecasts since December 2003 can be downloaded from this ftp server, utilizing a very fast Internet connection of 1 Gbit per second. The filename convention of the GRIB files is MFSTEP_CENTER_TTDDMMYY_XXX.grb where TT, DD, MM and YY are the time, date, month and year (respectively) of the initial time and XXX is the forecast time (in hours). CENTER corresponds to the originating center, e.g. IASA, MF, CHMI. Information about the structure of the various directories and the data included in the IASA ftp server are available online.

The Aladin/Mfstep data are also available to all project partners. The dedicated ftp site had to be established for the dissemination of these data. Due to the limited capacity of CHMI Internet connection (2Mbits per second) which is used also for commercial and operational products and because this traffic may be heavily disturbed in the case of many partners trying to download these data, other solutions were sought. Kind offers of cooperating partners (IASA and INGV) to use their ftp servers, from where the download shall be more comfortable and less problematic for the project partners, helped CHMI to propose the following solutions:

- SVP data have been uploaded to IASA ftp server ftp.mg.uoa.gr
- SVP data can be also sent on DVD to interested partners if requested
- no download of SVP data from CHMI is possible
- pre-TOP and TOP data are available on ftp server of CHMI ftp.chmi.cz. User and password will be provided to project partners on request. The retention time of these data on the ftp server will be three days
- pre-TOP and TOP data are also uploaded to INGV data server data.bo.invg.it. If this solution proves to be stable and acceptable by all involved project partners, the upload to ftp server of CHMI can be stopped due to the reasons explained above.

Any details about the ftp servers of Meteo-France can be provided to the interested partners on request.

It is reminded that the total size of the GRIB files for both Aladin/MFSTEP dissemination domains is about 4.05MB per range. Thus, for 1 day of assimilation one has 28 of such files (still feasible for Internet download). But in case of +120h forecast (albeit only once a week) the total amount of data is almost 0.5GB.

The operational SKIRON/Eta outputs (produced in the framework of MFSTEP) are also available as graphics through the web-page of WP10 http://forecast.uoa.gr/mfstep/ (Figure 1). Some of the available fields are the 10m wind, the mean sea-level pressure, the accumulated precipitation, the 2m temperature, the cloud fraction, the SST etc. An example with the T+48 forecast of the precipitation amount and the mean sea-level pressure from the operational run initiated at 0000 UTC on 10 March 2004 appears in Figure 2. The presentation of the Aladin/Mfstep outputs in the graphical format for the public is not considered due to the constraints given by WMO Resolution 40 and associated internal rules of the ALADIN consortium. The web-page of WP10 also provides an alternative link for online access to the SVP and TOP fields (through the "On-line Data" option), useful information about the partners, links to the deliverables of WP10 and documentation of the models employed in the various tasks of WP10.

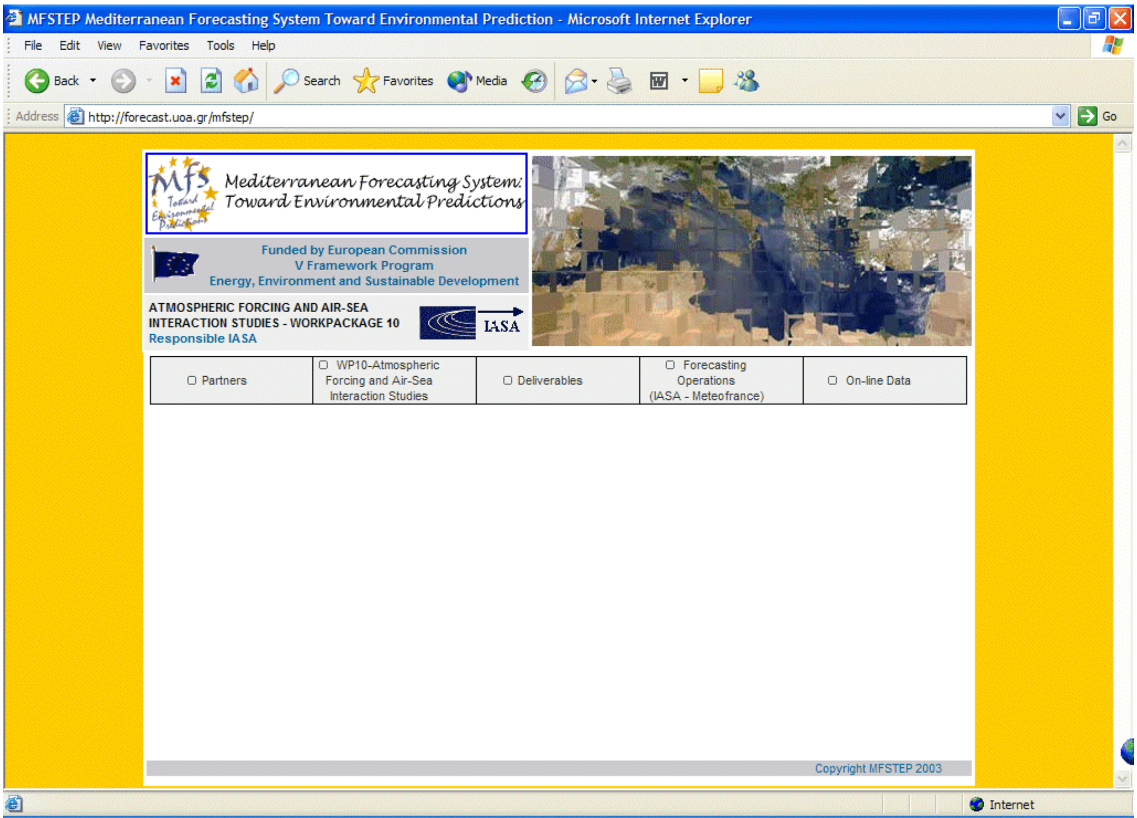

Figure 1. The home page of MFSTEP-WP10

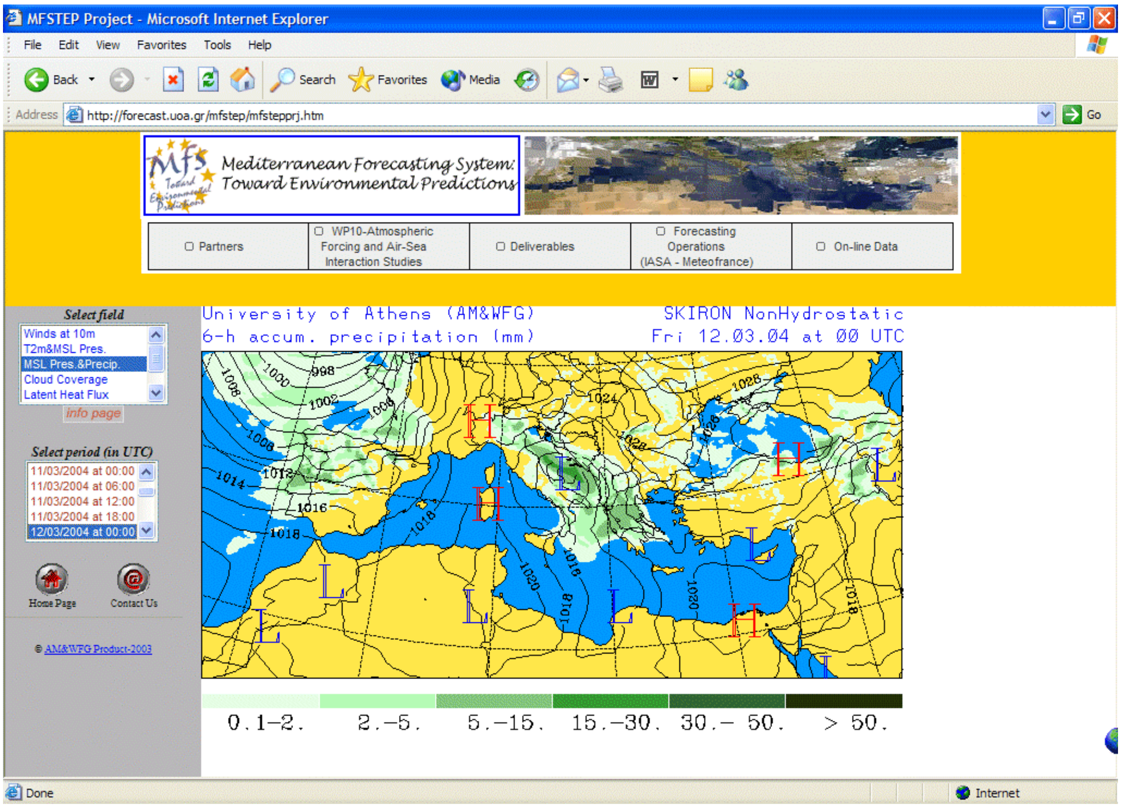

Figure 2. An example of the SKIRON/Eta output within the MFSTEP-WP10 web page.

The home page of MFSTEP-WP10 can also be accessed through the "Active Projects" section of the home page of the IASA/AM&WFG group (Figure 3). In the Active Projects section, the user may find links to MFSTEP-WP10, to other EC Funded programs such as ADIOS, ANEMOS, AUTOHAZARD-PRO, ENVIWAVE, MERCYMS, and to Greek Funded projects of IASA. This allows the accessibility of the project to increase since the visitors of the AM&WFG/IASA web page through other projects will have the opportunity to access MFSTEP. In needs to be noted that the web page of AM&WFG/IASA is very popular with approximately 4500 visitors daily from whom only 45% are from Greece.

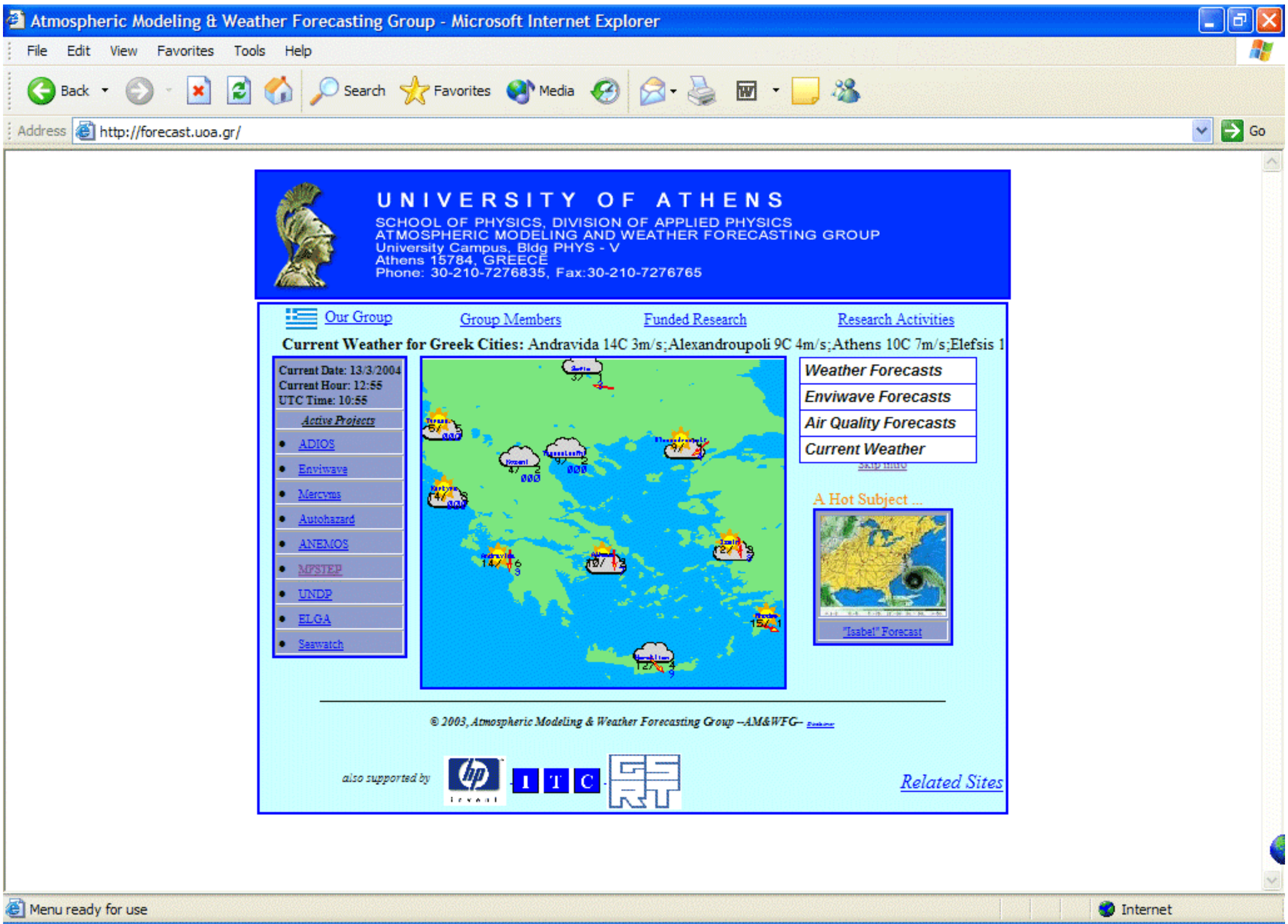

Figure 3. The AM&WFG/IASA web page

Results

The Skiron/Eta and the Aladin/Mfstep SVP and TOP data are available to project partners via dedicated ftp servers and the MFSTEP-WP10 web page, as it was described above.

Deliverable state

Del Number	Description	State	Dissemination date
D8	Data Set	Completed	31/08/03

Partner info			
N°	10	Acronym	UAT
Subtask info			
N°	10210	Title	Usage of high-resolution SST in atmospheric model initialization

Abstract

IASA and UAT developed (and are currently testing) the necessary algorithms in order to pre-process the high-resolution SST product (1/16 x 1/16 degrees) that will become available by WP3.

Data and methods

High-resolution SST data will be used by SKIRON/Eta modelling system in hindcast mode simulations. The main aim of these experiments is to investigate the influence of sharp SST gradients on the atmospheric flow regimes. These fields are elaborated in WP3 and the final datasets will become available in the following months.
During SVP and TOP, the SKIRON/Eta modelling system utilizes high-resolution SST data provided operationally at a resolution of 0.5 x 0.5 degrees. Thiebaux et al. (2003) showed that the use of these high-resolution SSTs by ETA model resulted to improved forecasts of storm track and precipitation over Eastern US. The WP3 SST datasets will be provided at the very high resolution of 1/16 x 1/16 degrees. The fact that the resolution of the WP3 SSTs is finer than the 10 km resolution of SKIRON/Eta implies that new algorithms were necessary for the experiments of subtask 10210.
IASA and UAT developed the necessary algorithms in order to decode and pre-process the high-resolution product. In SKIRON/Eta the SSTs are calculated on the h-points of the Arakawa E-grid. All the input SST values that lie within each grid-box are taken into account in the calculation of the initial SST field. Special attention is given in the computation of the SSTs near the coastline and in data void regions. Demo files are currently used for the development and testing of the necessary algorithms.

References

Thiebaux, J., E. Rogers, W. Wang, and B. Katz, 2003: A new high-resolution blended real-time global sea surface temperature analysis. Bull. Amer. Meteor. Soc., 84, 645-656.

Deliverable state

Del Number	Description	State	Dissemination date
D9	Report	In Progress	31/08/04

Partner info			
N°	11	Acronym	IASA
Subtask info			
N°	10310	Title	DEVELOPMENT OF SEA SURFACE SUBMODELS

Abstract

The Skiron/Eta modelling system calculates the surface parameters using a viscous sublayer scheme. IASA and ICOD have started improving the calculation of the surface parameters giving special emphasis in the formulation of the 10m. wind over the sea. The viscous sublayer over the ocean is assumed to operate in three different regimes depending on the roughness Reynolds number. In the calculation of the Reynolds number the roughness length is considered to be a function of the friction velocity. The new scheme and particularly the conditions that define the transition between the various sea-state regimes are currently being evaluated using the operational forecasts.

Data and methods

In the calculation of the surface fluxes, the similarity theory requires prescription of boundary conditions at two levels above the surface. The values at the lowest model level are used as the upper boundary condition. On the other hand, the profiles of the relevant atmospheric variables tend to have the log form as the lower boundary is approached. Since the log function has a singularity at z=0, it is usually assumed that the log profile ends at some small but finite height z_0 (roughness length), and that the considered variables take their lower boundary values at this height. This situation is illustrated in Figure 1(a).

The situation near the surface is more complicated and the profile of Figure 1(b) that includes a viscous sublayer is more realistic. This thin sublayer reflects the fact that near the surface there is no enough space for turbulent elements to develop.

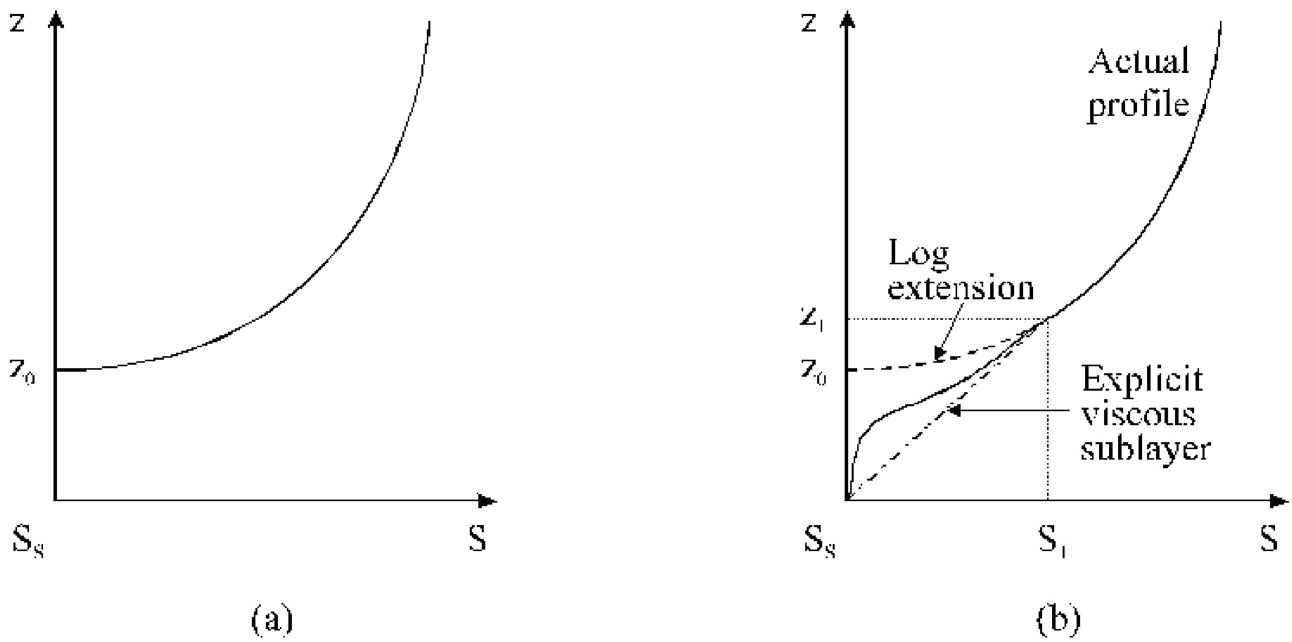

Figure 1. (a) log profile ending, and (b) log profile with the viscous sublayer ending

More specifically, two distinct layers are assumed near the surface: (i) a thin viscous layer immediately above the surface, where the vertical transports are determined entirely by the molecular diffusion, and (ii) a turbulent layer above it, where the vertical transports are defined entirely by the turbulent fluxes. The depth of the viscous sublayer depends on the respective physical variable that is calculated (e.g. T, u, q).

The viscous sublayer over water surfaces in Skiron/Eta model is designed by matching the log profile of the considered variables with a separate viscous sublayer profile (Janjic 1994). Thus, the lower boundary values for the turbulent layer are defined by specifying the value of the variables at the matching point.

The viscous sublayer over the ocean is assumed to operate in three different regimes: (i) smooth and transitional, (ii) rough and (iii) rough with spray, depending on the roughness Reynolds number

$$\mathrm{Re} = \frac{z_0 u_*}{\nu}$$

The roughness length is not constant over the sea but it is assumed to be a function of friction velocity:

$$z_0 = \max\left(0.018\frac{u_*^2}{g}, \quad 1.59 \times 10^{-5}\right)$$

When the Reynolds number exceeds a prescribed value Re_r the flow ceases to be smooth and the rough regime is entered. In the rough regime, the momentum is also transported by pressure forces on the roughness elements and the viscous sublayer for momentum is turned off. However, the viscous sublayer is still operating for heat and moisture until the rough regime with spray is reached at a critical value Re_s. At this point the viscous layer collapses completely. In the rough regime with spray the breaking waves and the spray are assumed to provide much more efficient way of exchange of heat and moisture between the ocean and the air than that can be accomplished by the molecular viscosity. Note that instead in terms of Re, the boundaries between the regimes can be expressed in terms of u_*, since Re is a monotonic function of u_*.

The threshold friction velocities at which the transition between the different flow regimes occurs are investigated. The values currently used are 0.225 m/s and 0.7 m/s.

Results

The new formulation was tested in hindcast mode and it has been incorporated in the operational version of the model. The new scheme is currently being evaluated using the operational forecasts.

Deliverable state

Del Number	Description	State	Dissemination date
D11	Report	In Progress	28/02/05

Partner info			
N°	45	Acronym	SIM-ARPA (ex SMR-ARPA)
Subtask info			
N°	10430	Title	Adriatic Sea area

Abstract

Meteorological fields from a LAM running daily at the partner's meteorological service is being used to calculate air-sea exchange fluxes needed by the ocean circulation model employed in the WP09 for the Adriatic region.

Data and methods

Several months within TOP will be chosen where the results from the model will be evaluated against available experimental data in the Adriatic Sea, already available at the partner's Institution. The atmospheric model, named LAMI (Limited Area Model Italy), originally developed at the German meteorological service DWD (Doms and Shatter, 1999) is a finite difference, primitive equations, non-hydrostatic model using sigma coordinate and with 7 Km of spatial resolution and 3 hourly outputs, nested offline in the global model GME of DWD (Majewsky et al., 2002).

Ongoing research, in junction with other institutions, is providing a validation of the surface fields in the Adriatic Sea, using offshore platform data, RADARSAT images and coastal stations data (Askari et al, 2003, Chiggiato, 2004, Signell et al, 2004, Trosić et al, 2003).

Results

The Meteorological fields (air temperature, relative humidity, wind velocity, precipitation and total cloud cover) from the LAMI meteorological model are available and will be provided for the purposes of the subtask 9510 by the scheduled period T24.

The procedure to calculate air-sea exchange fluxes, needed by the ocean circulation model, were prepared and are under test. Some first results are available from the related report by Chiggiato et al. 2004.

References

Askari F., R. P. Signell, J. Chiggiato, J. Doyle, 2003. *RADARSAT mapping of Bora/Sirocco winds in the Adriatic Sea*. Proceedings of IGARSS, IEEE International Geosciences and Remote Sensing Symposium, Toulouse (FR), **1**: 236-238.

Chiggiato J., Deserti M., Pinardi N.,Zavatarelli M., 2004. "HEAT FLUXES CLIMATOLOGY IN THE ADRIATIC SEA FOR THE PERIOD 1998 – 2001 COMPUTED FROM DIFFERENT DATA SETS", submitted to "Science of the Total Environment".

Chiggiato, J., 2004. Hydrodynamical modelling of the Adriatic Sea forced with different operational atmospheric models data sets. PhD Thesis, University of Bologna.

Doms, G. U. Shatter, 1999. *The Nonhydrostatic Limited Area Model LM (Lokal-Modell) of DWD. Part I: Scientific Documentation*. Deutscher Wetterdienst (DWD), Offenbach (Germany). Available at the website www.cosmo-model.org.

Majewsky, D., D. Liermann, P. Prohl, B. Ritter, M. Buchhold, T. Hanisch, G. Paul, W. Wergen, J. Baumgardner, 2002. *The operational global icosahedral-hexagonal gridpoint model GME: description and high resolution tests*. Monthly Weather Review, 130:319-338.

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Trosić, T., M. Kuzmić, M. Tudor, J. Chiggiato, 2003. *Ad hoc comparison of two atmospheric model predictions: a case of February 2003 Bora*. 13th Aladin workshop, Prague.

Deliverable state

Del Number	Description	State	Dissemination date
WP10- D15	Data (Atmospheric fields for subtask 9510)	In progress	29 February 2005 (24)

Partner info			
N°	11	Acronym	IASA
Subtask info			
N°	10520	Title	Evaluation of the sea-surface winds based on wave parameters

Abstract

In the framework of subtask 10520 IASA provides the necessary atmospheric fields to drive the open ocean wave models. It produced 72-hour hindcasts initialized from the daily 0000 UTC of January 2003, while 120-hour forecasts are produced operationally every Wednesday since December 2003. All the model outputs have been archived in the IASA database. Moreover, IASA has setup the procedures in order to make these data available online to the partners through its ftp server and the WP10 web page.

Data and methods

In the TOP and SVP periods of MFSTEP, IASA utilizes the nonhydrostatic SKIRON/Eta modelling system at high-resolution (0.1 x 0.1 degrees). 120-hour forecasts are produced operationally once every week (on Wednesday) since December 2003, utilizing the 0000 UTC cycle ARPEGE fields as initial and lateral boundary conditions. Moreover, IASA produced 72-hour hindcasts initialized from the daily 0000 UTC ARPEGE analyses of January 2003. The corresponding ARPEGE forecasts were used as lateral boundary conditions. 31 SVP simulations are available to the ocean modellers.

The computational domain is the full model domain covering the whole Mediterranean region and part of Central Europe. The dissemination domain of SKIRON/Eta model extends from 29°N to 48°N and from 11°W to 42°E. The meteorological fields which are available to the project partners in the dissemination domain include the u and v component of the 10m. wind, the 2m. air temperature, the 2m. specific humidity, the cloud fraction, the mean sea-level pressure, the total accumulated precipitation, the downward/upward shortwave and longwave radiative fluxes, the evaporation, the surface latent and sensible heat flux, the land-sea mask and the sea-surface temperature. These fields become available every hour up to 120 hours in regular latitude-longitude format (0.1x0.1 degrees). The accumulated precipitation is also accumulated in hourly increments. The SST field should be used in combination with the land-sea mask field because it is not valid over the land. Standard GRIB encoding for the model output has been adopted.

The Skiron/Eta output that resulted from the SVP hindcasts and the TOP forecasts have been archived in the IASA database. Moreover, IASA has setup the necessary procedures to make the model output available online, as soon as the model integration is completed. The address of the IASA ftp server is ftp.mg.uoa.gr (IP: 195.134.91.103) and the interested partners can be provided with a username and password. Alternatively, the GRIB-files can be accessed through the MFSTEP-WP10 web page by clicking on the option "On-line Data" and using the provided login and password.

Finally, in the framework of subtask 10310 IASA is in the process of evaluating a new formulation of the surface parameters that has been incorporated in the operational version of the model. Special attention was given in the calculation of the 10m. wind which is a crucial parameter in ocean modelling. In SKIRON/Eta model the near-surface fields are modelled using a viscous sublayer scheme. According to the new formulation, the viscous sublayer over the ocean is assumed to operate in three different regimes: (i) smooth and transitional, (ii) rough, and (iii) rough with spray, depending on the roughness Reynolds number. In the calculation of the Reynolds number the roughness length is a function of the friction velocity.

In conclusion, the ocean modellers are provided with a large number of atmospheric datasets in order to integrate their wave models and to evaluate extensively the predicted wave parameters. The fact that the atmospheric models produce 5-day forecasts on an operational base for a long period allows the ocean modelling community to choose the best cases for their tests. Any improvements in the formulation of the surface parameters in SKIRON/Eta model will also be very beneficial for the aims of subtask 10520.

Deliverable state

Del Number	Description	State	Dissemination date
D17	Report	In Progress	01/03/06

Partner info			
N°	35	Acronym	IOLR
Subtask info			
N°	10520	Title	Evaluation of the sea-surface winds based on wave parameters

Abstract

The wave-forecasting model WAM is currently running operationally at IOLR on two grids – coarse resolution for the entire Mediterranean Sea and fine resolution for the region east of 22°E. Wind forcing is provided by the SKIRON atmospheric model from the University of Athens. The forecast period is 72 hr. In addition, wind fields from the UK Met Office's global model are also being archived for future comparisons. The wave forecasts are verified against measurements conducted at the Hadera wave station. Preliminary results show that the SKIRON forced forecasts perform quite well, especially during extreme storms. The forecasts are available at http://isramar.ocean.org.il.

Data and methods

The wave-forecasting model WAM is currently running in a daily operational cycle at IOLR. The forecasts are provided on two grids – a coarse resolution grid of 0.5° covering the entire Mediterranean Sea and a fine resolution grid of 0.125° covering the region east of 22°E. Wind fields are provided by the SKIRON atmospheric model, which is run at the University of Athens. The winds are available on a grid of 0.2° with a temporal resolution of 6 hr.

Results

In the configuration described above, 72 hr wave forecasts are provided daily for the entire Mediterranean and for the Levantine and Ionian basins. These forecasts are available at http://isramar.ocean.org.il. The forecasts are verified against the wave measurements conducted at the offshore Hadera wave station. Preliminary comparisons of the measurements and the forecasts have been quite encouraging. The predicted wave heights and timing are quite satisfactory. Special attention has been paid to extreme winter storm conditions. For example, in Figure 1 we show the 18 hr forecast of the SKIRON surface winds and our coarse grid WAM forecast for the entire Mediterranean for the first day of the storm that occurred on 22-24 January 2004. In Figure 2 we show a comparison of the 24 hr predicted wave heights from our fine grid model and the observed wave heights from the Hadera station. The close match between the observed and predicted wave heights as well as the ability of the forecasts to correctly capture the timing of high wave events further confirm the quality of the SKIRON winds.

For future comparison in hindcast studies, 96 hr wind forecasts from the UK Met Office are also being archived. These forecasts are available on a grid of 0.833° X 0.555° at 12 hr intervals. A comparison will be made between the SKIRON forced wave forecasts and the UKMO forced forecasts for selected periods.

Deliverable state

Del Number	Description	State	Dissemination date
WP10-D17	Report describing the evaluation procedures followed and the scores	In progress	28/02/06

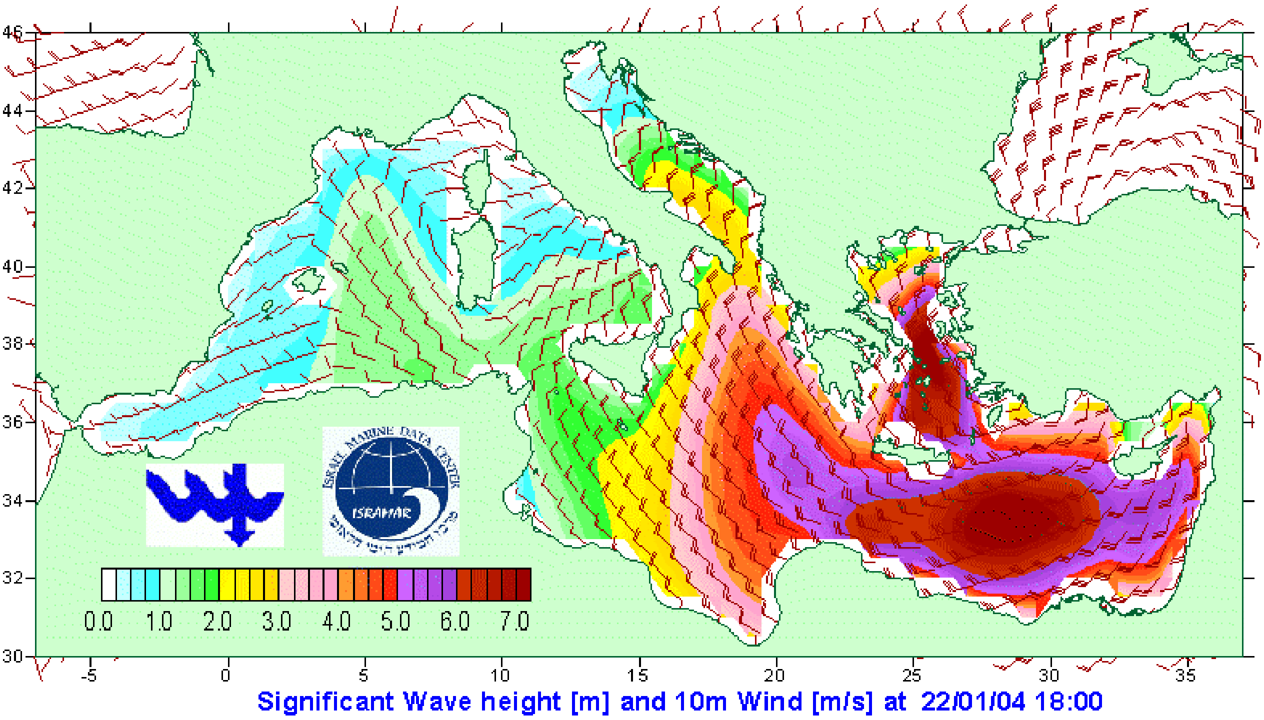
Significant Wave height [m] and 10m Wind [m/s] at 22/01/04 18:00
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0
ISRAMAR

Fig 1

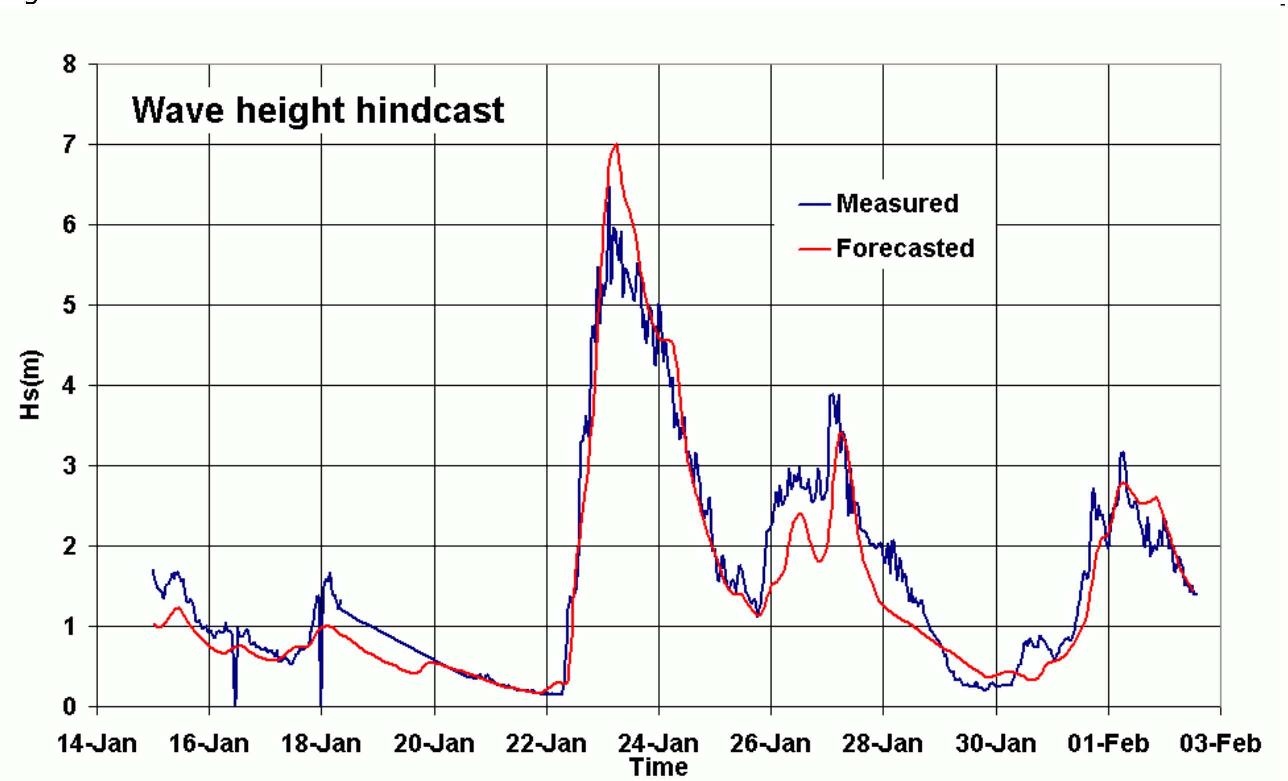
Wave height hindcast
Measured
Forecasted
Hs(m)
Time
14-Jan 16-Jan 18-Jan 20-Jan 22-Jan 24-Jan 26-Jan 28-Jan 30-Jan 01-Feb 03-Feb

Fig 2

Partner info			
N°	8	Acronym	UPC
Subtask info			
N°	10520	Title	Evaluation of the sea-surface winds based on wave parameters (calculated by using the atmospheric model winds) and wave observations.

Abstract

The wind is one of the main forcing factors related with surface waves and currents. Therefore wind modelling, calibration and validation are key elements. It is presented preliminary results of two wind models (MASS and ARPEGE) validations with meteorological stations at the catalan coast and a sensitivity analysis of state of the art wave models (WAM and SWAN) to such wind fields during two severe wave storms. Wind models showed higher wind speeds than recorded and the ARPEGE presented the smallest errors. The wind models did not clearly show any spatial pattern one to each other, except at coastal areas where ARPEGE shows lower wind speed than MASS. The wave models follow the wind field decreasing significant wave height at the buoy locations with the ARPEGE model.

Data and methods

A selection of two intense wave storms at the Catalan coast were taken to evaluate and validate wind and wave models. The first storm occurred during November 2001 and produced considerable coastal damages. The second storm occurred during March-April 2002, even though it was not as intense as the November one it presented considerable wave height.

The wind fields used came from the Mesoscale Atmospheric Simulation System (MASS)(Codina et al., 1997) and the Action de Recherche Petite Echelle Grande Echelle (ARPEGE) (Deque, 1996). The MASS model is a 3-dimensional hydrostatic primitive equation mesoscale model designed to be run with horizontal resolution of about 10 to 100 km, with 20-40 levels in the vertical. It is operated at the North-Western Mediterranean with a spatial resolution of 0.16^0 generating wind fields every 6 hours. A nested grid is available with a resolution of 0.0833^0 and time resolution of 3 hours. The ARPEGE wind fields consist of one grid with a resolution of 0.25^0 and time resolution of 3 hours, it is used operationally at Meteo-France.

Measurements from 6 meteorological stations (Fig 1) at the Catalan coast were used to validate the models. For the MASS model it was applied a bi-linear interpolation while for the ARPEGE (because no data above land were available) it was used the nearest point or bi-linear interpolation if possible.

The wind fields from both models were used to force third generation wave models WAM (Monbaliu, et al., 2000) and SWAN (Ris et al., 1999). Both models consider wind growth, whitcapping, and four wave-wave interactions. However, WAM does not consider triad wave-wave interactions and it uses a variable cut-off while SWAN uses a fixed one. Additionally some differences in numerics are considerable as well. The wave models were used with the same spatial resolution as the coarse MASS model. The ARPEGE winds, thus, were interpolated to be re-scaled.

Wave measurements were used from 1 directional waverider buoy (Tortosa) and 3 scalar buoys (Llobregat, Blanes and Rosas) (Fig 1). Figure 2 shows wind and wave measurements during the November storm, it is evident the two peaks of significant wave height reaching up to 6 m.

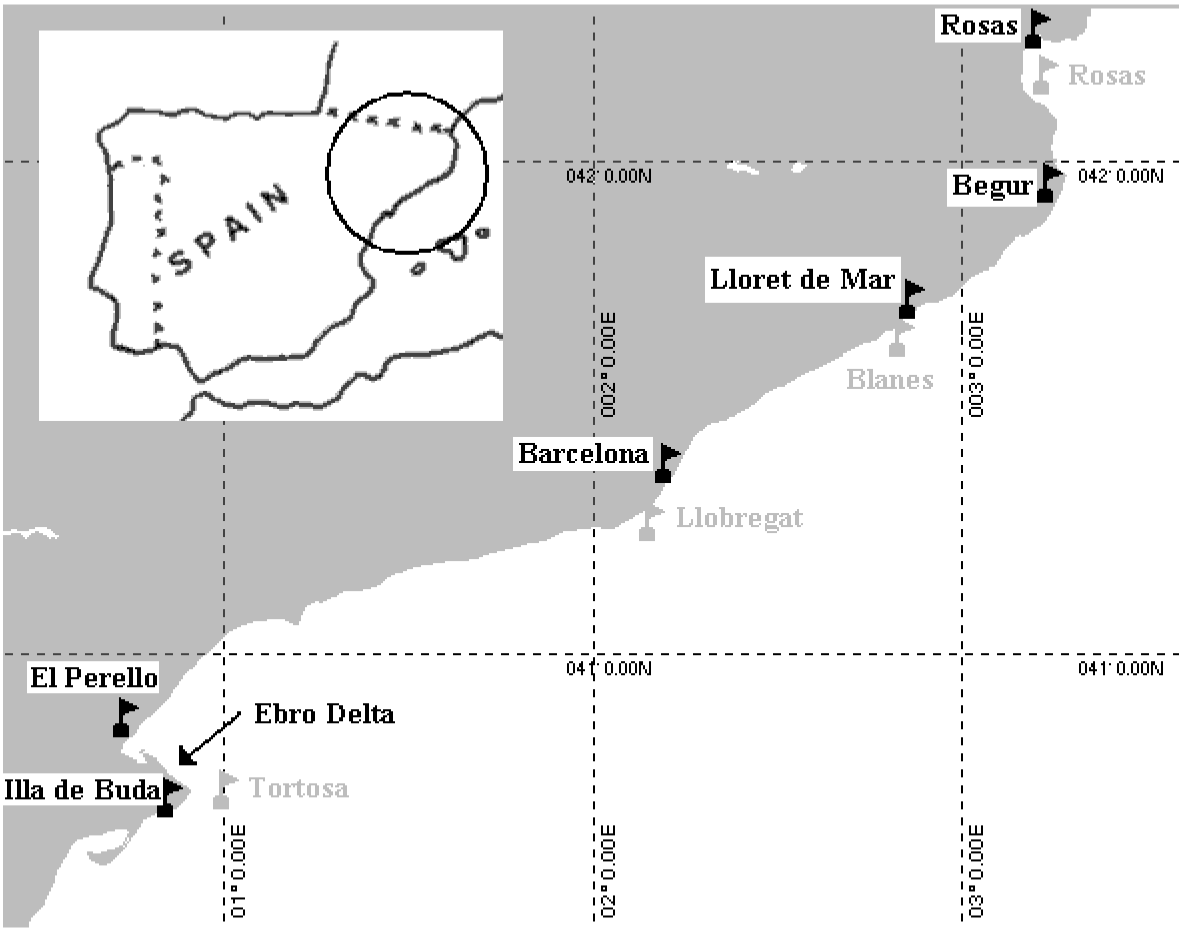

Figure 1. Meteorological stations and buoys location.

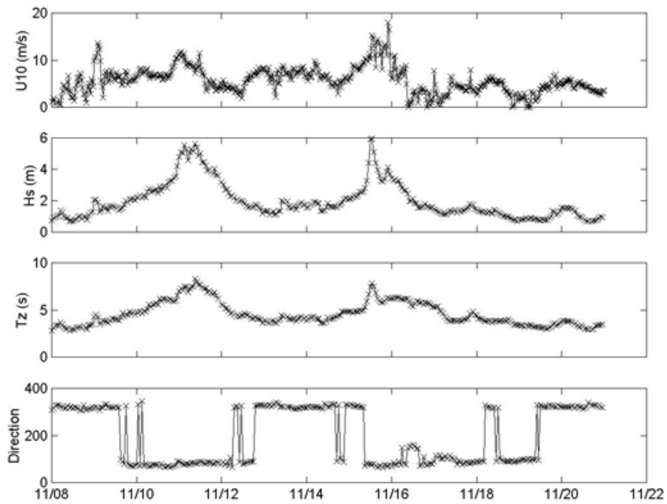

Figure 2. Wind and wave recorded data at Tortosa and Illa de Buda. November 2001 storm.

Results

Comparisons with meteorological stations show that for the most of the model cases a better agreement with the coarser grid, ARPEGE was the one with better performance. For most of the positions the models predicted higher wind speeds than measured (Fig 3), a fact attributed to "local" land influences on the meteorological station. Regarding the wind direction, models do not present large differences, although considerable differences with recorded data are found during some dates. The tables 1 to 4 show the errors of the wind models for both storm periods.

Location	Grid	Bias	RMSE	SI
Illa de Buda	Coarse	4.45	2.11	5.6
	Nested	5.97	2.35	8.10
Barcelona (Ciutadella)	Coarse	4.0	1.90	6.68
	Nested	3.16	1.7	4.65
Begur	Coarse	1.94	1.62	1.91
	Nested	9.27	2.93	12.89
El Perello	Coarse	-3.26	1.73	1.61
	Nested	0.06	1.37	0.80
Lloret de Mar	Coarse	6.54	2.44	32.04
	Nested	6.90	2.51	35.89
Rosas	Coarse	3.74	1.85	3.06
	Nested	7.15	2.59	8.76

Table 1 Bias, Root Mean Square Error (RMSE) and scatter index (SI) for the MASS model during the November storm.

Location	Grid	Bias	RMSE	SI
Illa de Buda	Coarse	0.9	1.2	1.1
Barcelona (Ciutadella)	Coarse	-0.2	1.1	0.9
Begur	Coarse	5.7	2.2	8.1
Lloret de Mar	Coarse	6.6	2.3	40.4
Rosas	Coarse	5.3	2.2	6.5

Table 2 Bias, Root Mean Square Error (RMSE) and Scatter Index (SI) for the ARPEGE model during the November storm.

Location	Grid	Bias	RMSE	SI
Illa de buda	Coarse	3.23	1.8	4.1
	Nested	4.17	1.9	7.3
Barcelona (Ciutadella)	Coarse	3.68	1.8	9.5
	Nested	5.11	2.1	15.9
Begur	Coarse	3.47	1.9	8.4
	Nested	5.26	2.2	15.5
Lloret de Mar	Coarse	4.26	1.9	15.4
	Nested	4.62	2.07	17.9
Rosas	Coarse	4.04	1.95	7.67
	Nested	4.16	1.96	8.94

Table 3 Bias, Root Mean Square Error (RMSE) and Scatter Index (SI) for the MASS model during the March-April storm.

Location	Grid	Bias	RMSE	SI
Illa de buda	Gruesa	0.9	1.2	1.1
Barcelona (Ciutadella)	Gruesa	2.5	1.6	4.5
Begur	Gruesa	0.08	1.1	1.6
Lloret de Mar	Gruesa	3.7	1.8	12.5
Rosas	Gruesa	2.9	1.5	5.9

Table 4 Bias, Root Mean Square Error (RMSE) and Scatter Index (SI) for the ARPEGE model during the March-April storm.

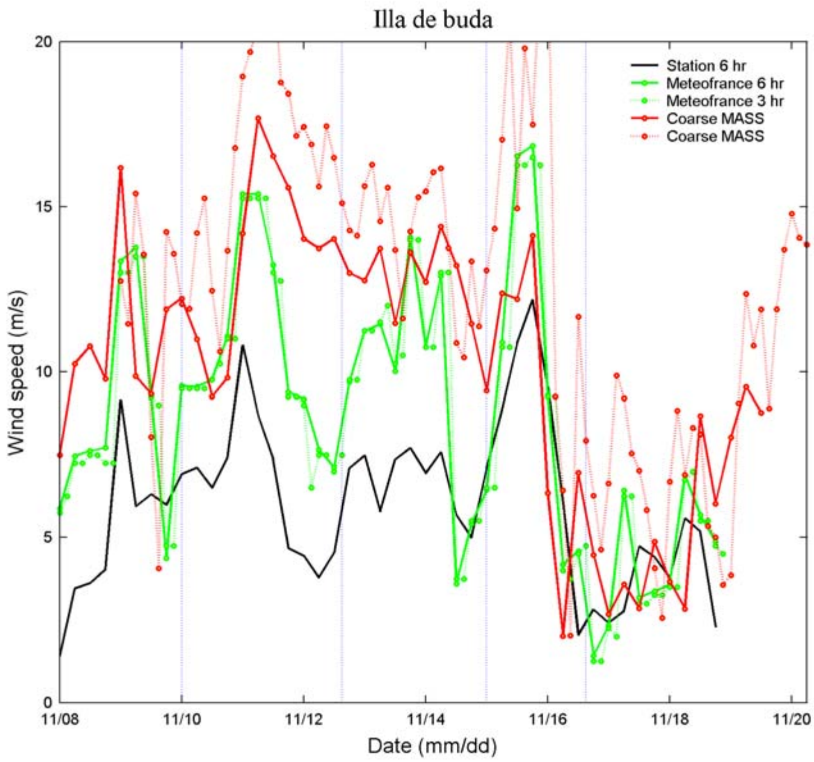

Figure 3. Wind speed measured and predicted at Illa de Buda. November 2001

The spatial distribution show different patterns for both storms. For the November storm, ARPEGE predicts higher wind velocities than MASS (except for the peak of the storm) over the Mediterranean Sea. Very close to the coast, the opposite occurs, being the wind from ARPEGE lower than those of MASS. For the March-April storm, the winds from MASS are larger all above the Mediterranean sea.

The wind field from both models were used to force the wave models and analyze the sensitivities and the effect of different wind fields when predicting severe wave storms. The wave model runs show interesting results; during the November storm the spatial distribution using ARPEGE shows a higher maximum wind and, thus, higher wind-waves at the Mediterranean Sea although the values of Hs at the buoy positions are lower than the ones forced by MASS (with both WAM and SWAN). This stresses the local effect of wind stress where ARPEGE presents lower wind velocity than the MASS. The SWAN runs show a better agreement in predicting the growing and waning of the storm peaks. The prediction of mean period was improved by the ARPEGE wind field. The situation is different during the March-April storm, when winds from MASS are higher and the waves forced by ARPEGE winds produce a considerable underestimation of significant wave height. Within this storm differences on Tz with both wind fields are not significant.

Figures 4 and 5 show time series of buoy measurements and wave prediction by WAM and SWAN forced by MASS and ARPEGE. It is evident the decrease in Hs produced by ARPEGE, this improves in some cases the prediction of the growth and decay of the storms but not the storm peaks. The SWAN model seem to fit better to the maximum wave height.

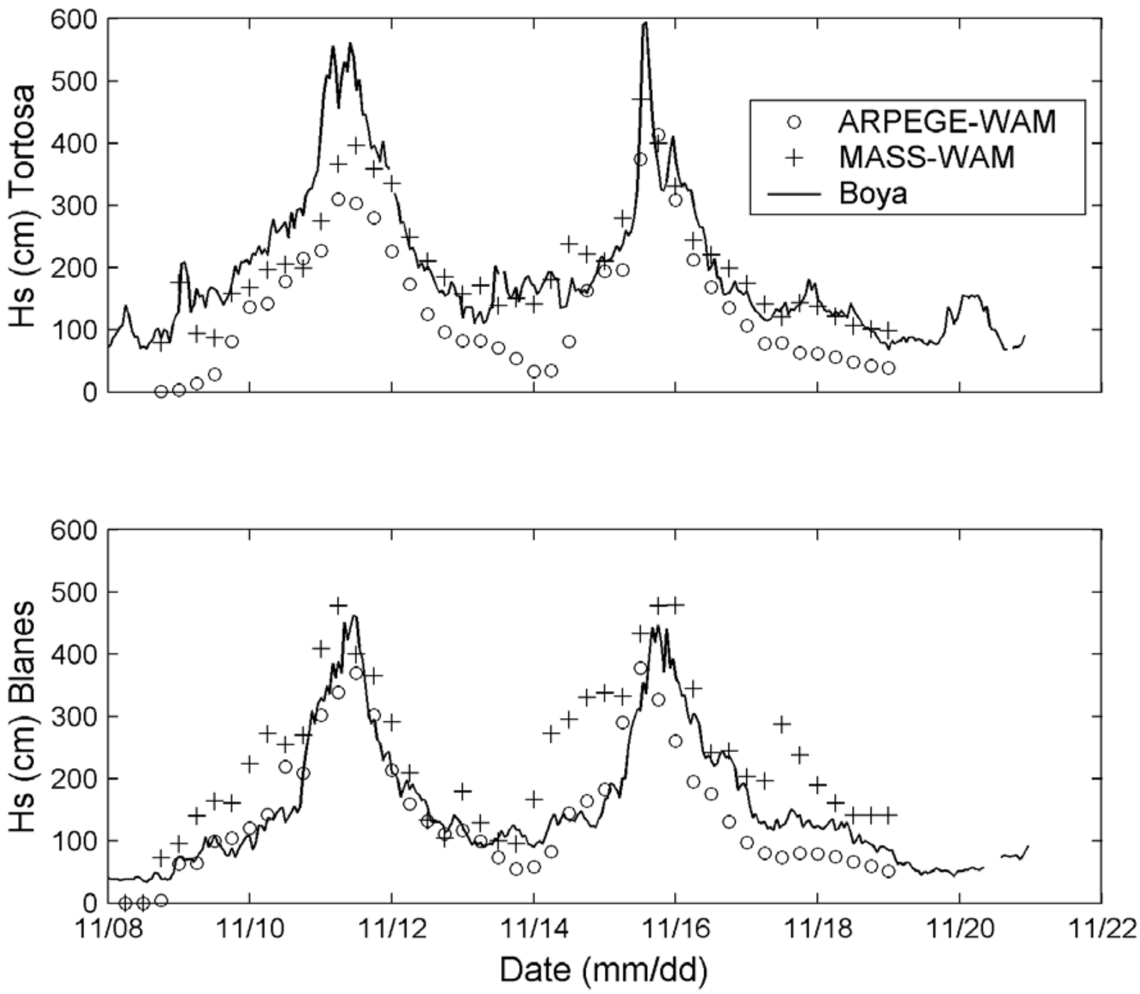

Figure 4. Significant wave height measured and predicted at Tortosa and Blanes with WAM

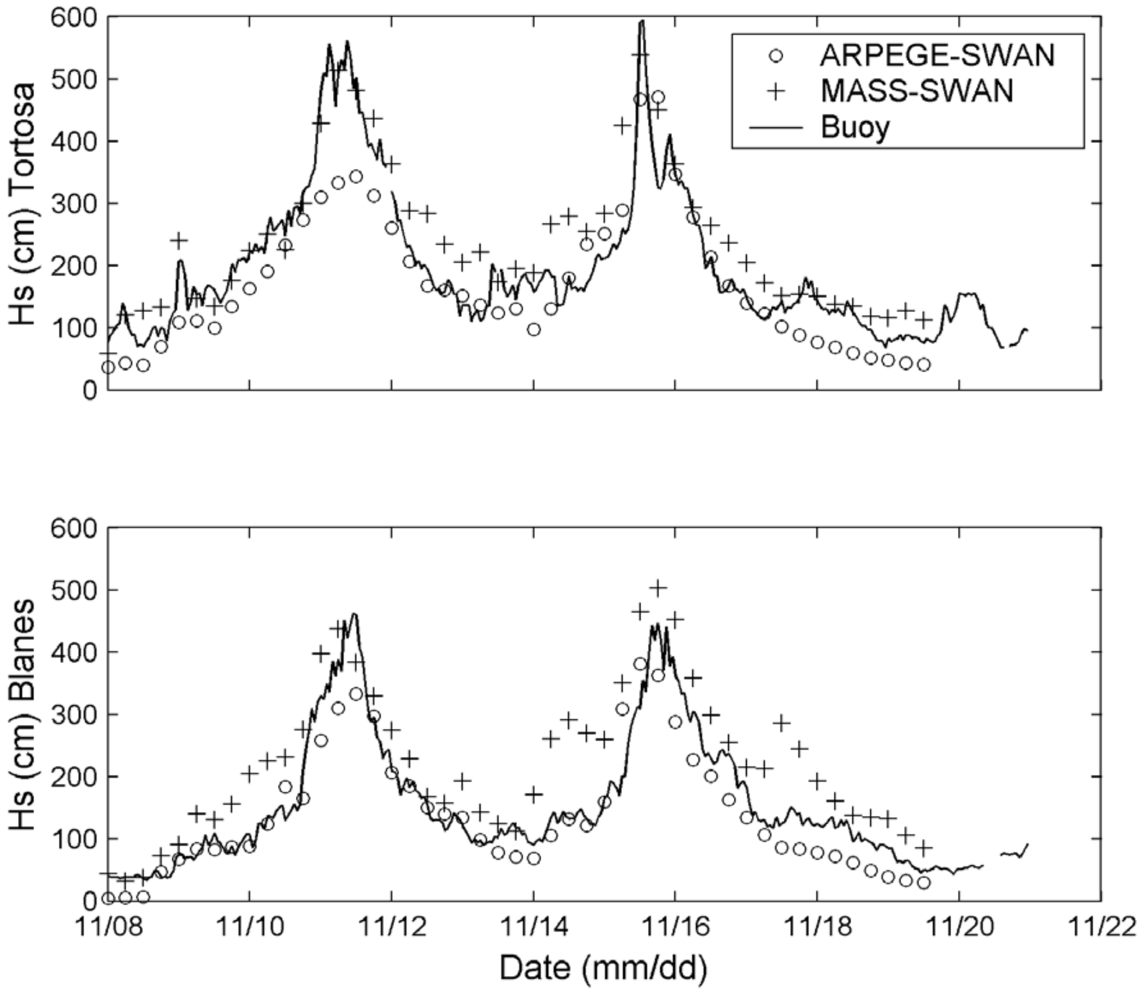

Figure 5. Significant wave height measured and predicted at Tortosa and Blanes with SWAN

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Deliverable state

Del Number	Description	State	Dissemination date
WP10-D18	Report describing the evaluation procedures followed and the score	In progress	28 /Feb/06

Publications related to the project (cumulative lists)

Non refereed literature:

Authors/Editors	Date	Title	Event	Reference	Type
Bolaños-Sanchez, R., Cateura, J., Sanchez-Arcilla, A	3-6 May 2004	Evaluation of two atmospheric models applied to wave forecasting in the NW-Mediterranean	36th International Liege Colloquium on Ocean Dynamics		Poster