Technical Report on the Global Data Processing and Forecast System
MAROC-METEO 2006 status

1. Equipment in use at the centre

- Information commutators on GTS are the TRANSMET computers (2servers, operating with OS Linux).
- the management of the forecasting system (control of the data in input of NWP models, postprocessing, production of charts with the NWP output) is made on a sun computer running Oracle RDBMS,
  - NWP operational models are running on a IBM RS6000 :

The system is an RS/6000 SP with 54 Giga Flops composed of 3 Nodes High (Night Hawk 2) :
  - Tow nodes of 16 processors for calcul
  - One node of 4 processors for file managing

The processor is a Power 3-II with 375 Mhz and develop a power of 1.5 Giga Flops.
The global machine central memory is 19 Go
The masse memory (RAID 5 discs) is 1019.2 Go

Software configuration:
AIX 5.1 ML3, XLF 8.1.1.1, C compiler 6.0, ESSL, MASS, LoadLeveler 3.1.0.21

List of compilation projects in al29T2 at that moment:
ald, arp, tal, tfl, ost, coh, sat, xrd, uti and odb

- Reception of forecast and observation products (from GTS included), in particular From the french centre, is made through special link with Toulouse and satellite Communication (RETIM2000 system).

2. USE OF DATA AND PRODUCTS FROM GTS
Average number of messages, by day:

AIREP	AMDAR	BUOY	SATEM	SHIP	SYNOP	TEMP
600	8000	5691	6334	6793	10118	418

3. DATA INPUT SYSTEM
Automated.

4. FORECAST SYSTEM
The operational forecast system at MAROC-METEO is based on several configurations of the code ALADIN, which uses extra software to run the limited area model NORAF and ALBACHIR.
The ALADIN library has been developed jointly by Meteo-France and the national meteorological or hydrometeorological services of the following countries: Algeria, Austria, Belgium, Bulgaria, Croatia, Czech Republic,Hungary, Moldova, Maroc-Meteo, Poland, Portugal, Romania, Slovakia, Slovenia, Tunisia.

5. Schedule of the Forecast System

The operational forecast system at MAROC-METEO is based on ALADIN, using the following rules :

ALADIN-NORAF configuration
HH 0000 UTC 1200 UTC
range 72H
ALADIN-MAROC (ALBACHIR) configuration
HH 0000 UTC 1200 UTC
range 72H

5.1 ALADIN NORAF:

This configuration covers the area of North Africa to the equatorial belt with a resolution of 31km. It is used to provide NWP products to the ACMAD countries. In fact Morocco was engaged to produce forecasts over North Africa with higher resolution than other NWP models actually in use in those countries. ALADIN NORAF is also used to provide the boundary conditions to an overlapping model ALBACHIR.

5.2 ALADIN MAROC (ALBACHIR):

Centred on Morocco with a finer resolution of 16km, this model is used by local operating services (short and medium range forecast, marine and aeronautic) and for other products for specific users.

The two NWP suites run on a super calculator IBM (RS/6000 SP). This machine is constituted from three nodes with 36 processors of 1.5 GFPLOS each (54 GFLOPS on the whole).

In parallel to the work on the operational models ALADIN NORAF and ALADIN MAROC, the numerical prediction team carried out several research projects in the aim to validate the new suite and to prepare future changes. The main research projects in 2006 concern data assimilation methods (3D-VAR, BlendVar) and forecast error statistics (called Jb) computation. OSEs[1] studies are also carried out in order to evaluate the impact of existent observation systems and the contribution of introducing new ones (see part II for more details). A preliminary study on Ensemble Prediction System (EPS) has been realised on the ALADIN NORAF model, but the capacity of our calculator IBM don't allow running it.

6. RESEARCH AND DEVELOPMENT IN DATA ASSIMILATION AND NUMERICAL FORECASTING

Data assimilation methods

A study about data assimilation methods was carried out. The aim was to realise several data assimilation cycles in order to single out the most adapted method to ALADIN NORAF context. The first step was the running of a cycle based on 3DVAR.

An other data assimilation method called "blending" was tested in this study. The goal of this technique is to create an initial state combining the «large scales» resolved by the ARPEGE analysis to the «mesoscale» features provided by the short-range ALADIN forecast. Blending is considered as mesoscale data assimilation "without using observations". The last data assimilation method (Blendvar) tested was a combination of Blending and 3D-VAR analysis. In this case the first guess for 3DVAR analysis is

---

[1] OSE : Observing System Experiment

created by the blending method. The main result of this study shows that Blendvar has the best impact in analysis and forecast performance.

In this issue, other studies to integrate other kind of observation data especially satellite data Atovs and Siviri was curried. A double suite of 3 Dvar is running and we wish to run it operationally as soon as possible.

Calculation of Jb term

A beta-plane horizontal balance has been developed and coded for the Jb term of the Aladin 3D-Var and for the associated software of error covariance calculations. In this study, instead of taking f (Coriolis parameter) constant over the Aladin domain, the formulation is based on a truncated spectral expansion of the meridional variations of the Coriolis parameter. It can be seen as a multi-diagonal approach, in contrast with the purely diagonal approach of the f-plane balance. This approach was first validated by examining, over the Aladin NORAF domain, the increase of explained variance by the beta-plane balanced geopotential, compared with the f-plane balanced geopotetial. The formulation was then coded in the Aladin 3D-Var, and it was validated by using in particular some single observation experiments.

Installation of CY29T2 on IBM/RS6000

The port of CY29T2 on IBM RS6000 entrained in the beginning some problems. After eliminating known sources of differences with the operational release, bit identical results were obtained for the configurations e001 including physics and ee927.

The most important ingredient in the new computation of heat and momentum mixing lengths is the diagnostics of PBL height. Here the original Ayotte algorithm was found unsatisfactory and therefore it was modified. New algorithm is referenced as Ayotte-Tudor-Piriou-Geleyn (ATPG). In addition, there are further small improvements as the protection to avoid too small PBL height detection because of surface soil temperature. Next ingredient here is the function fitting more regularly the mixing length curve, both for momentum and heat.

The setup of the SLHD scheme is now general and resolution independent; this is a great advantage for the wide use of the scheme. See details in the note "Semi-Lagrangian Horizontal Diffusion in ALADIN/ARPEGE", Filip Váňa, 2005. The namelists of ALADIN/CE were modified accordingly. This scheme is now under test in ALADIN-MAROC in order to introduce it in the opertional suite.

Ensemble prediction system

The ensemble prediction system acquires an increasingly important place in the meteorological centres throughout the world. Thus, Maroc-Météo decided to open a shutter of research on this topic.

The method used for perturbing the initial condition and so getting 36 members is based on the combination of multi-analysis and multi-guess system. Three different methods of analysis are used : 4D-Var, 3D-Var and Optimal Interpolation. From each method of analysis, we run 12 analyses while using each time a different guess which makes on the whole 3*12=36 members.

This work is not yet complete; a very important stage is to do: the statistical processing of this large quantity of data. Tools of visualisation and verification are in progress of elaboration. The capacity of our calculator doesn't allow running this kind of suites. We hope in future to be able to provide the first graphics results of the ensemble prediction.

7. RESEARCH AND DEVELOPMENT RESULTS FOR APPLICATION OF NWP PRODUCTS

Add and plotting of new parameters : The model ALADIN NORAF covers the equatorial belt characterised by deep convection and strong storms. Recently, we have added the post processing of new parameters like CAPE (Convective Available Potential Energy), CIN (Convective INhibition) and TCLW (Total Cloud Liquid Water) useful for characterising convectif systems. Figure 1 is an example of this parameters plot.
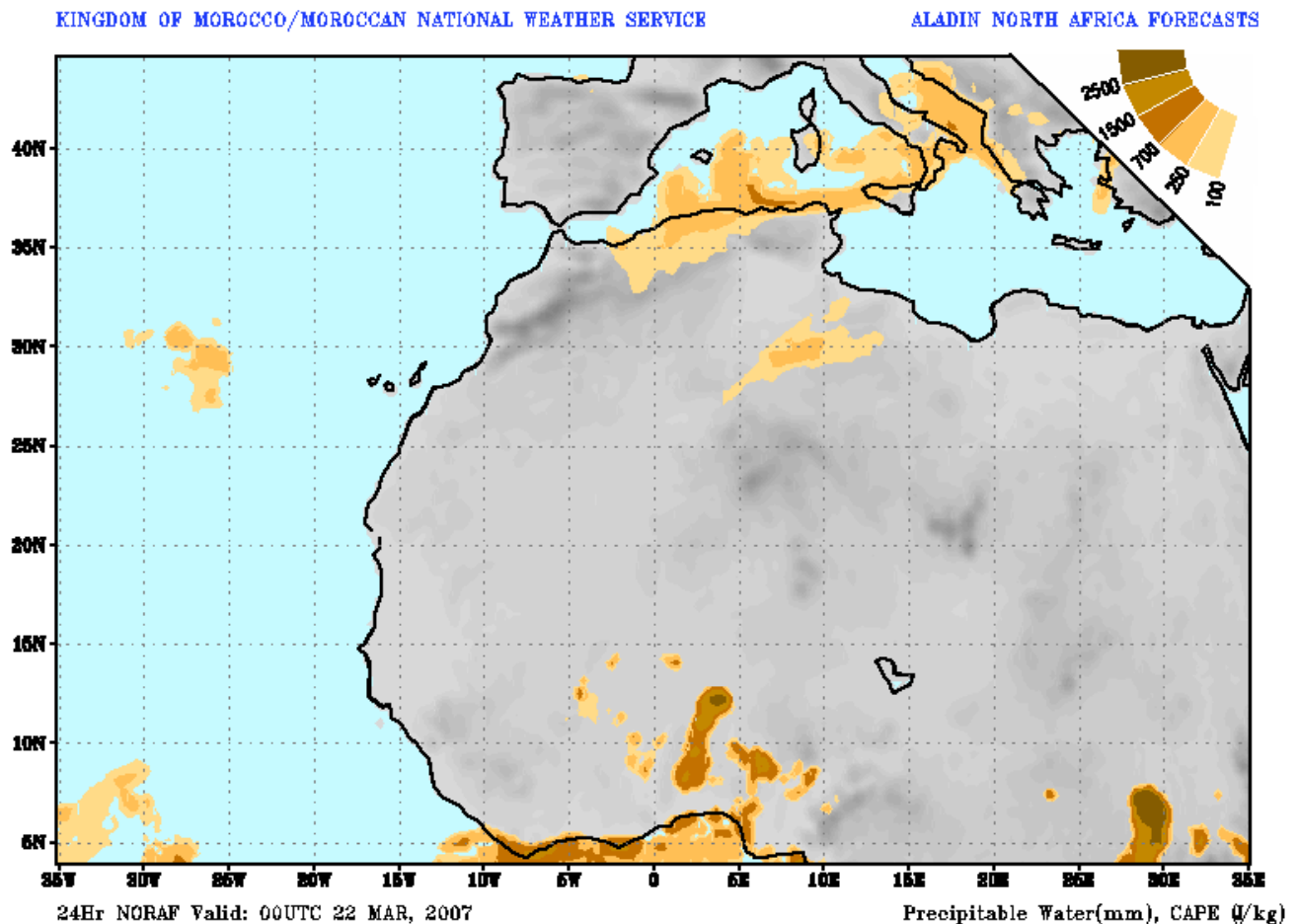

Figure 1 :CAPE and Precipitable water of ALADIN NORAF model

Fight against crick : Morocco is one of west-African countries affected by cricks invasion. The motion of cricks groups is strongly controlled by meteorological conditions

like rain, humidity and wind. A special model output is produced to help fighting forces to better localise areas to be disinfected.
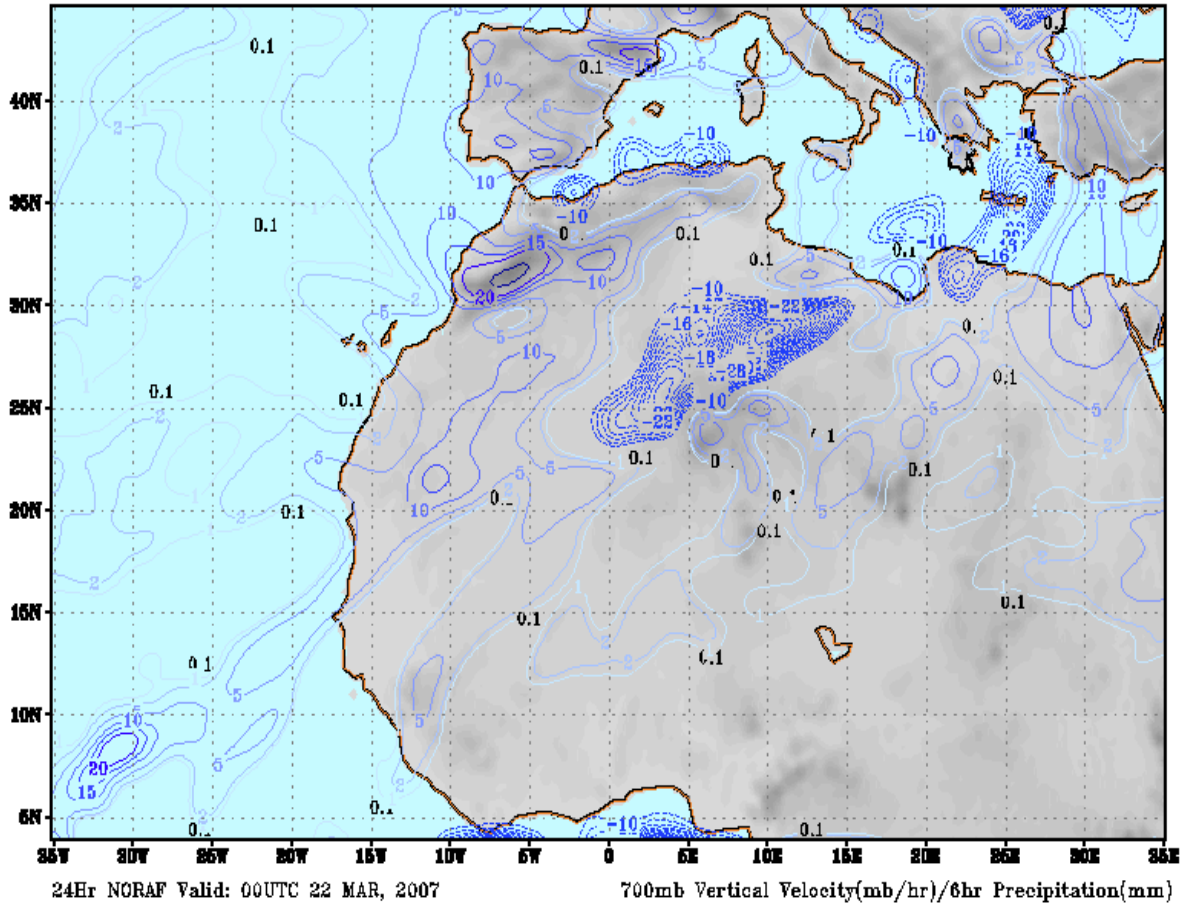
8. OUTSTANDING RESEARCH AND DEVELOPMENT ACTIVITIES RELATED TO IMPROVEMENT OF THE OPERATIONAL SYSTEM

As it said above, the NWP system in Morocco is composed of two parts:

1] **ALADIN NORAF**: it covers the North Africa area in the aim to respond the ACMAD demand in terms of forecast products with fine resolution. the domain concerned is between 44.8° North, -1.9° South, -35.3° West and 57.2°East with a horizontal resolution of 31km. The vertical resolution is given by 37 layers. We use a time step value equal to 900s. The integration frequency is twice a day (00 and 12 UTC). The forecasting range is 72 hours and the post-processing is performed every six hours. The coupling files coming from the French ARPEGE global model (via a fast connection with Toulouse (128kb)) are transformed into 31km resolution on the above mentioned area thanks to a post-processing configuration called e927.

ALADIN NORAF is running in dynamical adaptation mode without data assimilation. Morocco is among the pioneers in the ALADIN consortium who use data assimilation in limited area model. It was valid for ALADIN MAROC model and we try to keep the same interest for data assimilation methods with the ALADIN NORAF model. An optimal interpolation analysis was used in the operational suite in the near past but problems with our local BDM constrained us to stop CANARI and to run the model by dynamical adaptation. Observations were provided by the local observation data base. However, there is a weakness in conventional observations cover, what has to direct us to potential use of the satellite observations. In this context, 3D-VAR seems to be the appropriate data assimilation method than CANARI. Research work was carried out in this direction and concretised in a double suite with 3D-VAR data assimilation mode.

Some ALADIN NORAF outputs (charts of meteorological parameters at several levels)) are available in internet in the following address: http://www.marocmeteo.ma/spn.
Hereafter some examples of NORAF products:

24Hr NORAF Valid: 00UTC 22 MAR, 2007   700mb Vertical Velocity(mb/hr)/6hr Precipitation(mm)

24Hr NORAF Valid: 00UTC 22 MAR, 2007   200mb Streamlines and Isotachs (m/s)

24Hr NORAF Valid: 00UTC 22 MAR, 2007   850mb Temperature(C), RH(%), Wind(m/s)
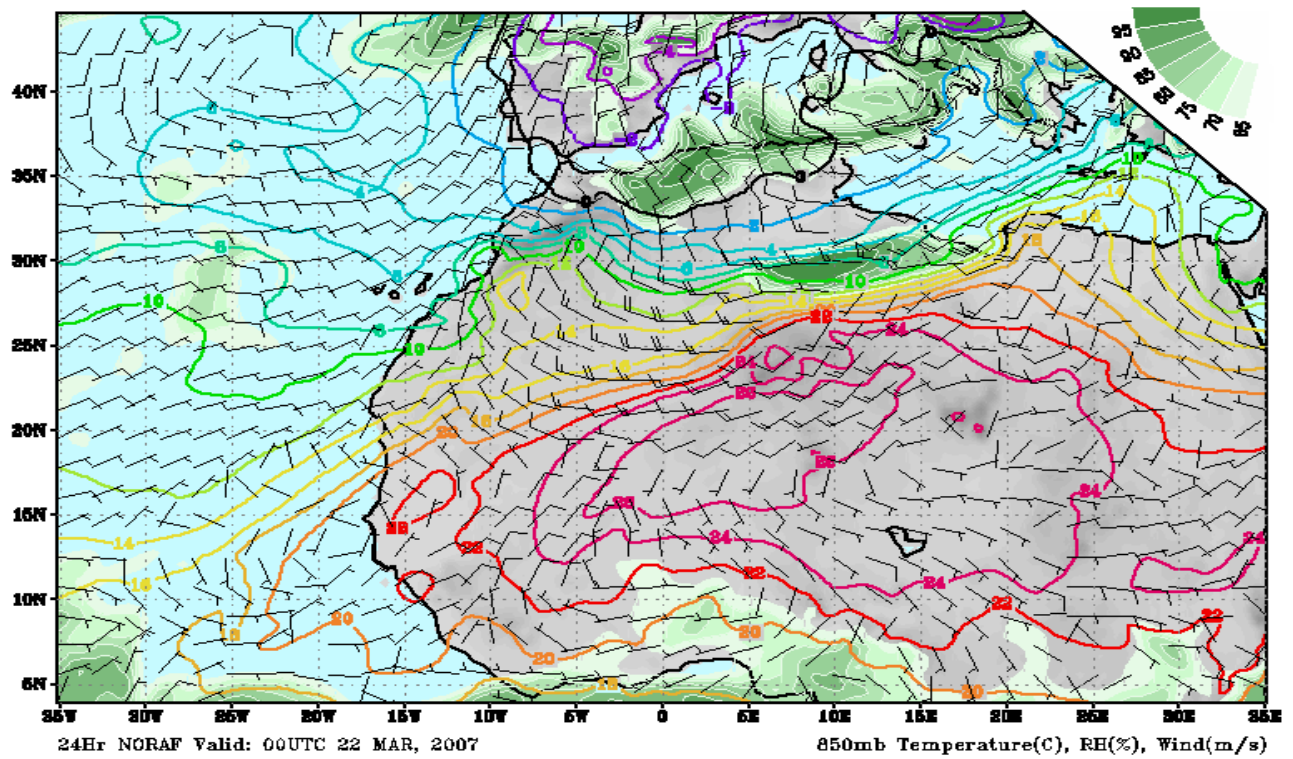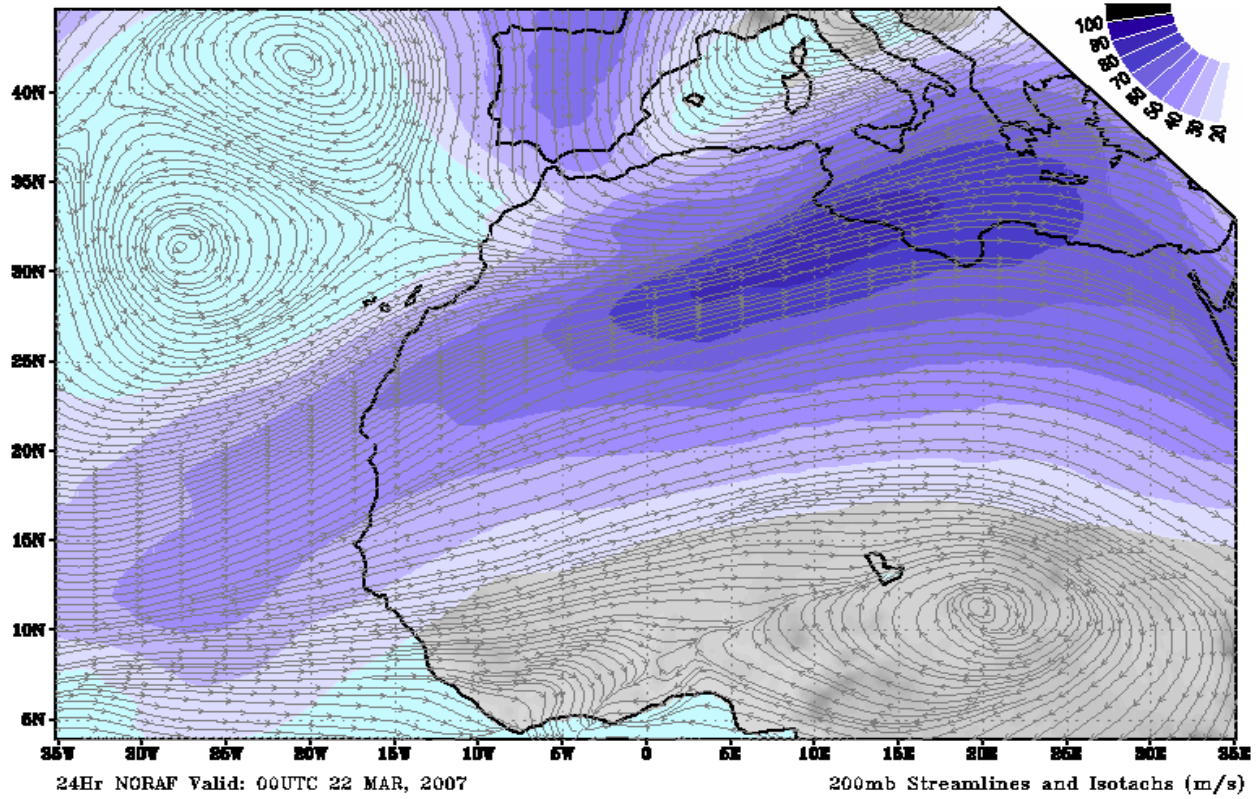
Figure 2 : Some forecast fields of ALADIN NORAF model

7

2] **ALADIN MAROC (ALBACHIR**): it is centred on Morocco with a resolution of 16.7km. Vertical resolution is 37 layers. Couplings files are provided by ALADIN NORAF model. The initial state is that of ALADIN NORAF transformed to the ALBACHIR domain tanks to the same procedure used for coupling file: the ee927 configuration. GRIB files are produced every 3 hours and are transmitted to operating centre and to the four regional meteorological centres in Morocco for local use.

3] **Some researches:**

In parallel with the operational suite some research subjects are done so as to improve in future the quality of the model prediction:

- The impact horizontal resolution on the predictability of convective cells over atlas mountains.
- The impact of vertical resultion on the predictability of fog by using AROME model in CASABLANCA international airport.

9. FUTURE PLANS:

As mentioned above, the IBM RS 6000 not allowed the implementation of high resolution models in MAROC-METEO, we are planning for changing it at the beginning of 2008.
Our objective for the 6th future years is:
- ✓ Increase of NORAF resolution about 16 Km.
- ✓ Implementation of ALARO limited area model with a resolution about 7 Km.
- ✓ Implementation of AROME limited area model on small area with a specific climate coupled with ALARO with a resolution about 2.5 Km

10.REFERENCES

ARPEGE MEMORANDUM GCO APRIL 2005
Semi-Lagrangian Horizontal Diffusion in ALADIN/ARPEGE", Filip Váňa, 2005
Elouaraini, R., L. Berre, 2003 : Introduction of the β plane into the horizontal balance equation of Aladin Jb

Hdidou, F., Mathieu Nuret, 2006: Test de sensibilité de la chaîne 3D-Var Aladin-AMMA

Sahlaoui, Z., 2006 : Assimilation des radiances micro-ondes sur terre étude d'impact dans Aladin

SBII S. &,HELLO G. 2006 Prévision de quelques situations de brouillard avec AROME sur le MAROC.

ZIDANE A., SBII S. 2006, Impact du changement de la résolution des modèles ALADIN/MAROC sur la prévisibilité de quelques situations convectives.