Progress report on numerical weather prediction

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1. A brief summary of research development and main operational changes

The operational system consists of two parts :

1.1 ALADIN-NORAF

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

1.2 ALADIN-MAROC (ALBACHIR):

Centred on Morocco with a finer resolution of 17 km, this model is used by local operating services (short and medium range forecast, marine and aeronautic applications) and for other products for specifics users.

The two NWP suites run on a super calculator IBM (RS/6000 SP). This machine is composed of 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 futures changes. The main research projects in 2004 concern data assimilation methods (3D-Var, BlendVar) and forecast error statistics (called Jb) computation. OSEs[1] were also carried out in order to evaluate the impact of current 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 achieved with the ALADIN-NORAF model.

2. Research and development in data assimilation and numerical forecasting

2.1 Data assimilation methods

A study about data assimilation methods was carried out. The aim was to realize 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 3D-Var.

Another 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 a mesoscale data assimilation "without using observations". The last data assimilation method tested (Blendvar) was a combination of blending and 3D-Var analysis. In this case the first guess for 3D-Var analysis is created by the blending method. As main result, this study shows that Blendvar has the best impact in analysis and forecast performance.

2.2 Calculation of Jb term

A β-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 when using the β-plane balanced geopotential instead of the f-plane balanced geopotential. The formulation was then coded in the ALADIN 3D-Var, and it was validated using in particular single-observation experiments.

[1] OSE : Observing System Experiment

2.3 Installation of CY28T3 on IBM/RS6000

No significant changes were operated on code since the mother calculator is an IBM, only few changes in *odb* because of wrong interpretation of pre-compiler to the use of some characters as variables or as directives.

Hardware configuration :

The system is an RS/6000 SP with 54 GigaFlops composed of 3 nodes High (Night Hawk 2):

- 2 nodes of 16 processors for calcul,
- 1 node of 4 processors for file managing.

The processor is a Power 3-II with 375 Mhz and develop a power of 1.5 GigaFlops. 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 al28t3 at that moment: *ald, arp, tal, tfl, ost, coh, sat, xrd, uti* and *odb*

Compilation : *gmkpack*.5.7 was used

A detailed report will be given later including comparison with CY25T1. In this report comparison of request memory and time clock needed by every configuration will be compared with CY25T1. Namelists and changes will be commented.

2.4 Ensemble prediction system

Ensemble prediction systems acquire 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 conditions and so getting 36 members is based on the combination of multi-analysis and multi-guess systems. Three different methods of analysis are used : 4D-Var, 3D-Var and Optimal Interpolation. From each method of analysis, we run 12 analyses 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 still to do is the statistical processing of this large quantity of data. Tools of visualisation and verification are in progress of elaboration. The next months will know the first graphical results of the ensemble prediction.

3. Research and development results for application of nwp products

3.1 Add and plotting of new parameters

The ALADIN-NORAF model 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 characterizing convective systems. Figure 1 is an example of such parameters plot.

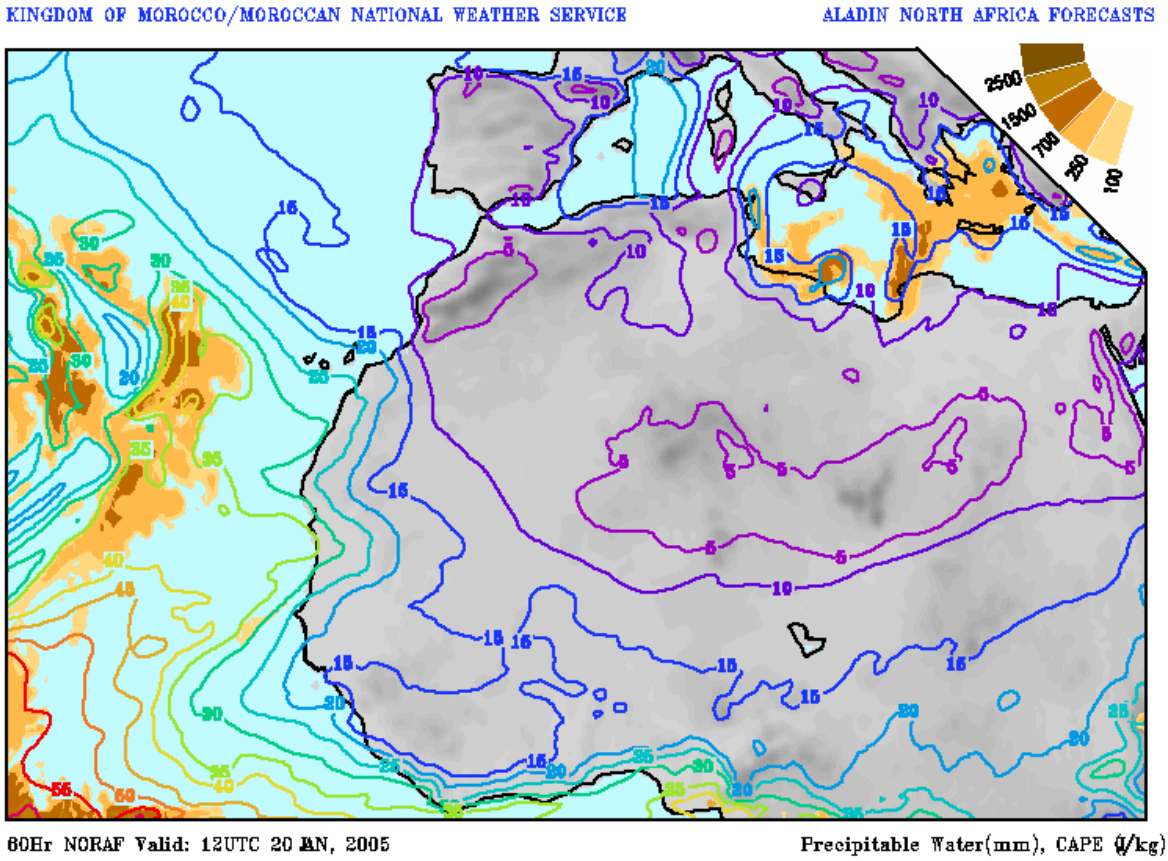


Figure 1 : CAPE and Precipitable water for ALADIN -NORAF

3.2 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.

4. Outstanding research and development activities related to improvement of the operational system

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

4.1 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 concerned domain is between 44.8° North, -1.9° South, -35.3° West and 57.2°East with a horizontal resolution of 31 km. The vertical resolution is given by 37 layers. We use a time-step value equal to 900 s. The integration frequency is twice a day (at 00 and 12 UTC). The forecast range is 72 hours and post-processing is performed every six hours. The coupling files coming from the French ARPEGE global model (via a fast connection with Toulouse, at 128 kb) are transformed to 31 km resolution on the above-mentioned area thanks to the "post-processing" configuration called ee927.

In a first stage, ALADIN-NORAF was running in dynamical adaptation mode without data assimilation. Morocco is among the pioneers in the ALADIN consortium to use data assimilation in a limited-area model. It was valid for the 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 (observation database) constrained us to stop CANARI and to run the model by dynamical

adaptation. Observations were provided by the local observation database. However, there is a weakness in the conventional observations coverage, which has to direct us to the use of satellite observations. In this context, 3D-Var seems to be a more appropriate data assimilation method than CANARI. Research work was carried out in this direction and put into concrete form in a double suite with 3D-Var data assimilation mode.

Some ALADIN-NORAF outputs (charts of meteorological parameters at several levels) are available via internet (see examples in Figs 2). Moreover, it is expected that, in a near future, GRIB files from the ALADIN-NORAF suite will be sent to ACMAD countries via a satellite RETIM connection.

4.2 ALADIN-MAROC (ALBACHIR)

It is centred on Morocco with a resolution of 16.7 km. 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 as used for coupling files : the ee927 configuration. GRIB files are produced every 3 hours and are transmitted to the operating centre and to the four regional meteorological centres in Morocco for local use.

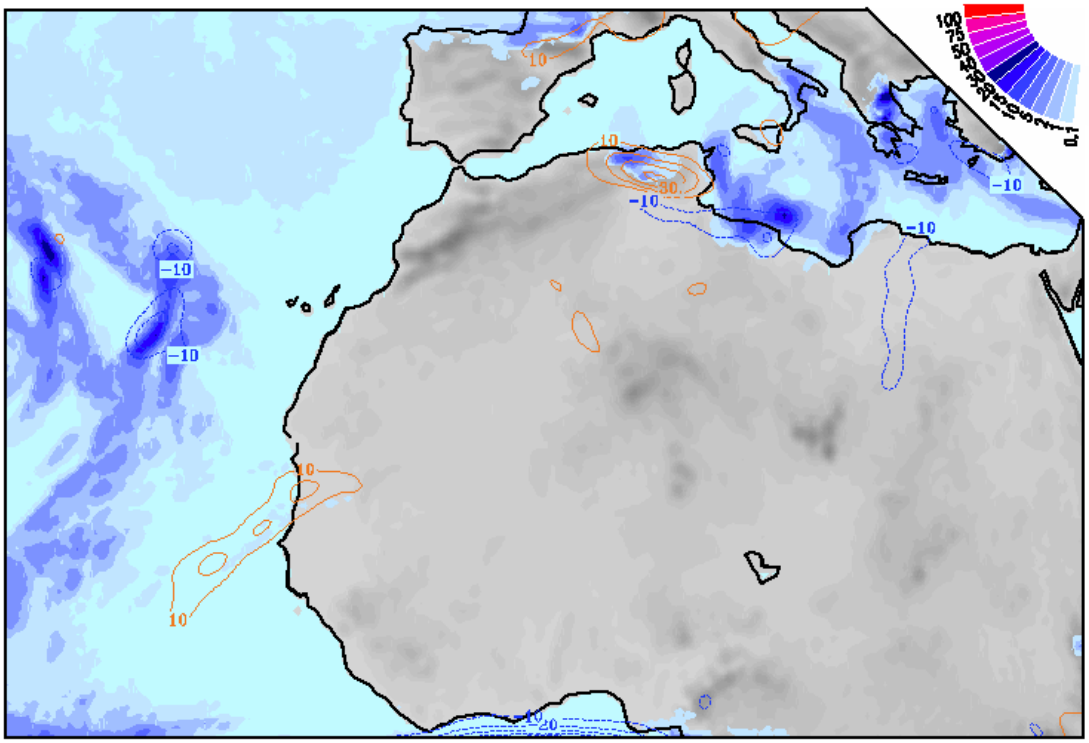
5. Reference

Elouaraini, R., L. Berre, 2003 : Introduction of the β-plane into the horizontal balance equation of ALADIN Jb

Hdidou, F., C. Fischer, 2002 : Mise en place d'une chaîne d'assimilation pour ALADIN NORAF basée sur la technique Blendvar

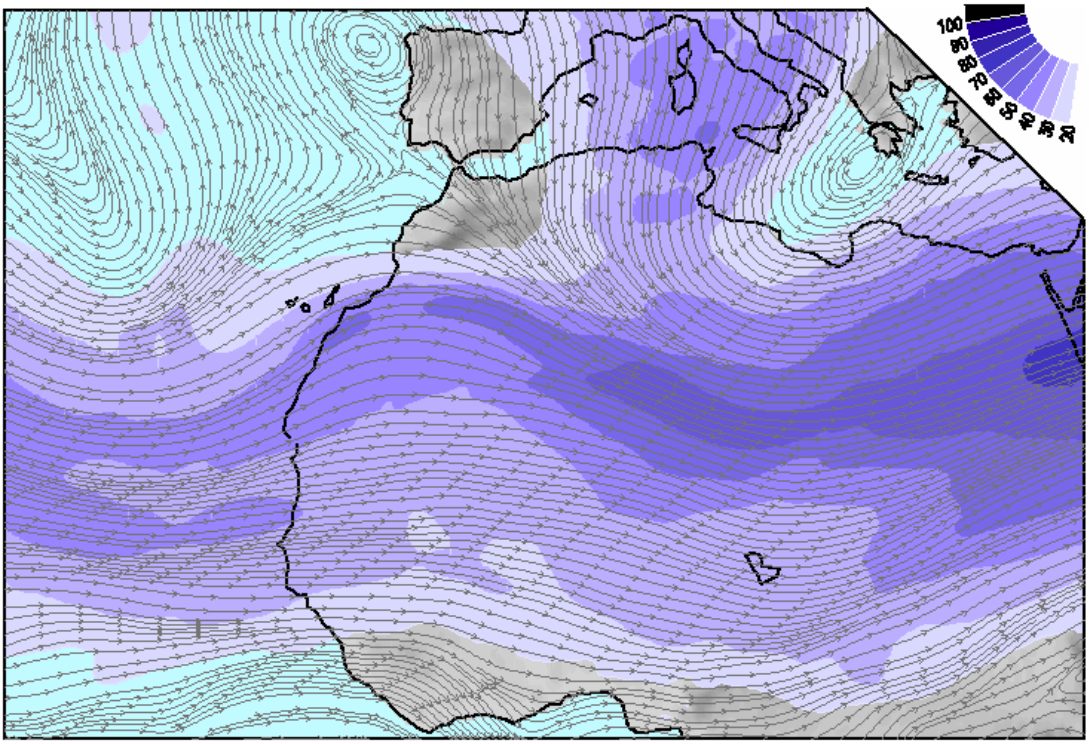
Sahlaoui, Z., E.Gerard, F.Rabier, 2002 : Assimilation of ATOVS raw radiances in ALADIN

KINGDOM OF MOROCCO/MOROCCAN NATIONAL WEATHER SERVICE ALADIN NORTH AFRICA FORECASTS



60Hr NORAF Valid: 12UTC 20 JAN, 2005 700mb Vertical Velocity(mb/hr)/6hr Precipitation(mm)

KINGDOM OF MOROCCO/MOROCCAN NATIONAL WEATHER SERVICE ALADIN NORTH AFRICA FORECASTS



60Hr NORAF Valid: 12UTC 20 JAN, 2005 200mb Streamlines and Isotachs (m/s)

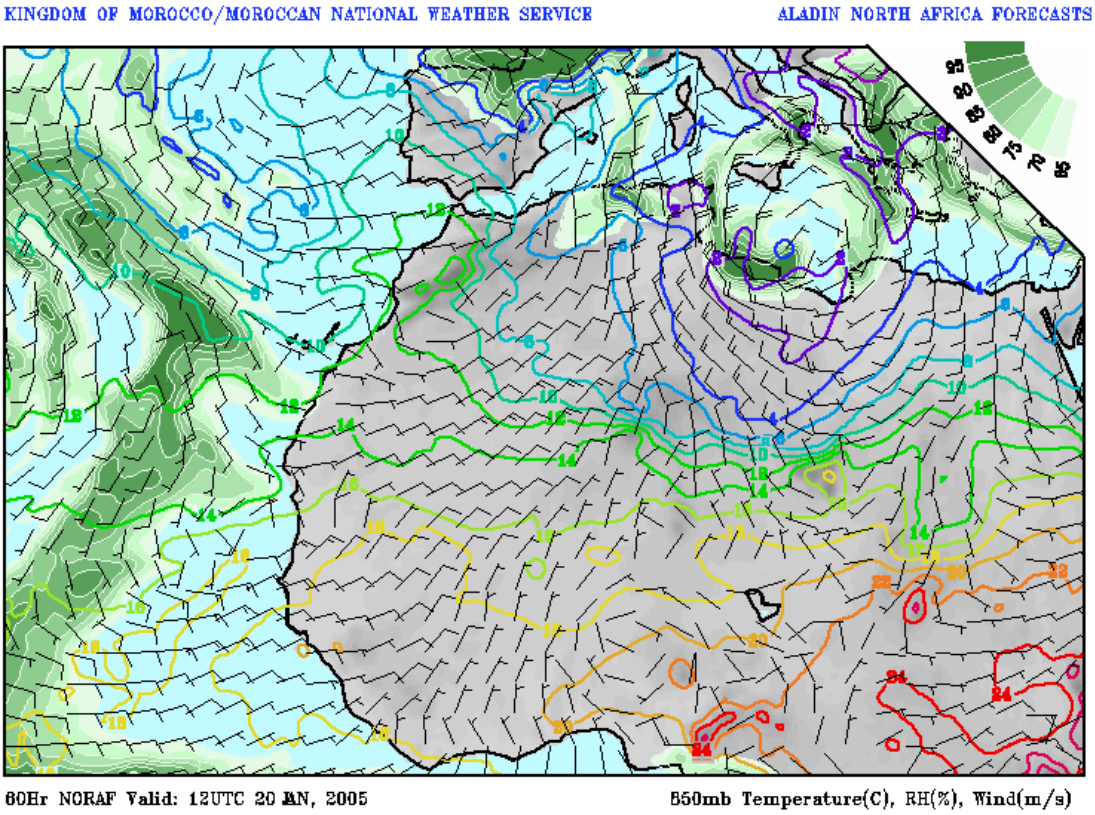


Figure 2 : Some forecast fields of the ALADIN-NORAF model

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