ALADIN PhD studies

1. Radi AJJAJI : "Incrementality deficiency in ARPEGE 4d-var assimilation system"

In order to be able to work at home on 4d-var problems (those linked with incrementality aspects), I tried to adapt the configurations involved into 4d-var on IBM at Casablanca. As we could run 3d-var before, the work was not very hard. The huge problem that I encountered was the large memory required by 4d-var for minimisation at truncation T95 (incorporating simplified physics). This is due to the activation of physics especially radiation (the coefficients are stored in memory). As I was running just on one node (9 GB memory and 16 processors with a blocking factor `NPROMA` of 31), it was impossible to achieve T95 minimisation. The solution that allowed me to solve this problem was to distribute work on two nodes by specifying 8 processors on each node.

Now, it is possible to run the old 4d-var with 3 outer loops (T42, T63 and T95) on IBM for a reasonable cost (90 minutes execution on 16 processors with CY22T2). I succeeded in reproducing the wrong increments due "eventually" to the high incrementality in ARPEGE 4d-var.

I performed some experiments on internal DFI into 4d-var in order to catch the impact of strong or weak constraint on the increments. But no major sensitivity to notice.

As many changes have been introduced on 4d-var since CY22T2, I am working on adapting CY25T1 to be able to run 4d-var in a newer context. ODB and all the applications related to it (Batodb, Shuffle, screening, minimisation) are already adapted.

2. Karim BERGAOUI : "Investigation of the potential of a convection scheme using prognostic mass fluxes for NWP in the African-Mediterranean domain"

Nothing new (operational tasks in Tunis).

3. Vincent GUIDARD : "Evaluation of assimilation cycles in a mesoscale limited area model"

1. Additional results on MAP IOP 14

(completion of the study described in the ALATNET Newsletter 5, "Combined use of 3d-var and DFI-blending on MAP IOP 14")

Some scores against observations were computed over precipitation forecasts. The forecasts were performed with constant coupling from several initial states valid at 12 UTC, 02 November 1999 :

- OPER : dynamical adaptation of ARPEGE analysis, digital filter initialization (DFI);
- DFI-blending : 24-hour DFI-blending assimilation, DFI;
- 3D-VAR : 24-hour 3d-var assimilation, incremental DFI;
- BLENDVAR : 24-hour Blendvar assimilation, incremental DFI;
- BLENDVAR+pseudo-prof. : 24-hour Blendvar assimilation, including pseudo-profiles of humidity in the last 3d-var analysis, incremental DFI.

Figure 1 shows the results for short-range forecasts, which reinforce the previous results : DFI-blending assimilation improves precipitation forecasts. The introduction of humidity pseudo-profiles implies some interesting modifications.

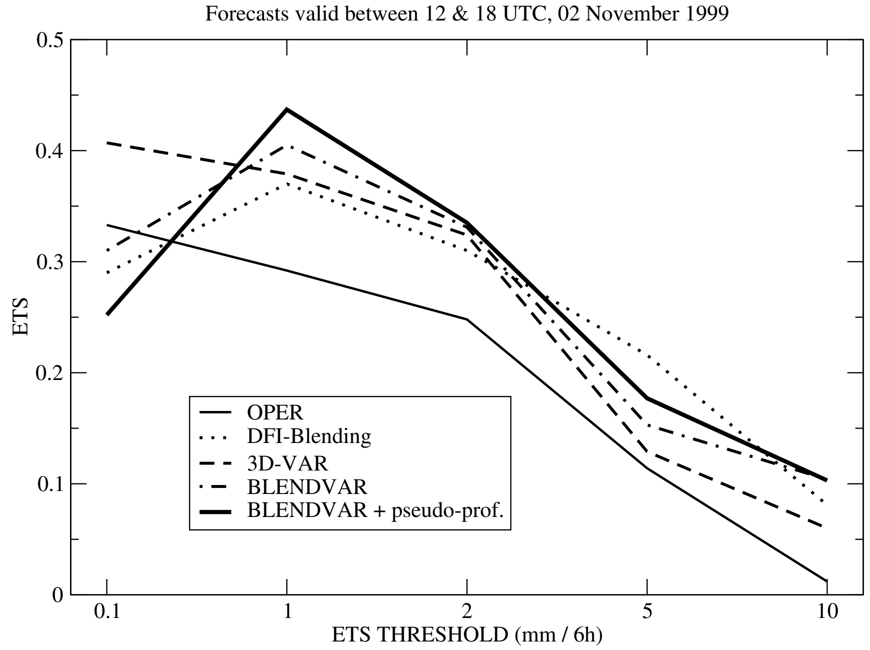

Figure 1 : Equitable Threat Score for short-range forecasts (ETS, the closer to 1. the better).

2. Biperiodisation & background error statistics : Impact on 3d-var analysis increments

‘‘Single observation’’ experiments

Some experiments using only one observation have highlighted a drawback of biperiodisation : if the observation is too close to the C+I border, one part of the analysis increment (roughly 10 % of the whole increment) goes through the extension zone and appears on the opposite side of the domain (Figure 2).

Two solutions were considered :

- enhancing the width of the extension zone, but this implies a recomputation of some statistics and an increase of the computational cost (therefore not tested) ;

- rejecting all observations closer than 200 km to the C+I border, but a little part of the increment still goes through the extension zone and too many observations would be rejected.

Similar experiments (not shown) were undertaken with a "band" of (real) observations instead of one (simulated) observation. The analysis increment generated by a 1000 km-wide band of observations in the southern part of the C+I domain is similar to a "single obs." increment. Neither rejecting the observations which are too close to the border, nor zeroing the σ_b in a rim zone around the domain, solve the problem. The analysis is still worse than the first-guess (in comparison with the observations) in that part of the domain where there is no observation (i.e., in this case, in the northern part of the C+I zone).

The next trial will consist of using the B-matrix auto-correlation functions as gridpoint filters (see below).

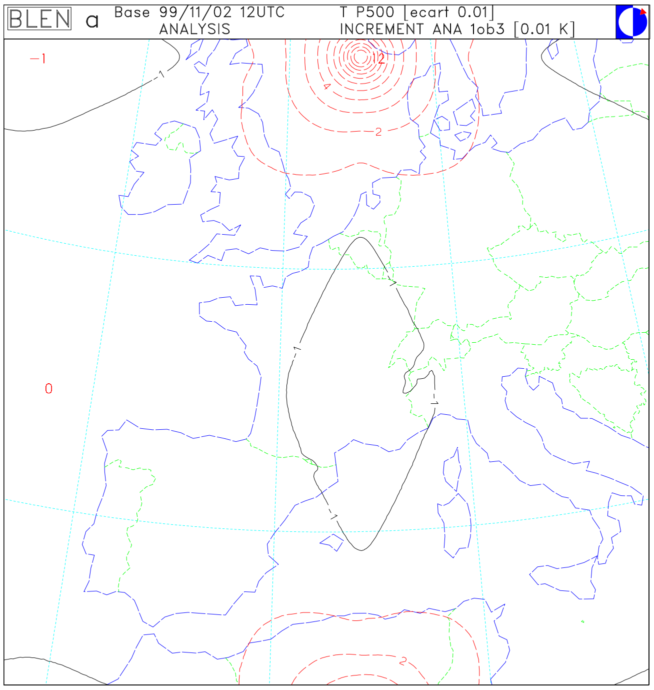

Figure 2 : Analysis increment for temperature at 500 hPa. The observation is a simulated TEMP observation of temperature at 500 hPa, verifying : observation - first-guess = 1 K. Units : 0.01 K.

Academic 1d model

An academic 1d assimilation model, with 300 gridpoints and no dynamics, is used to study in a simple way the gridpoint behaviour of the background error covariance spectrum and the impact of its modification. In order to damp the impact of an observation at long distance, a compact support has been implemented. It mimics ARPEGE ‘‘SUJBCOSU’’ routine, using a cosine-shape way to zero the gridpoint function. The first results are quite encouraging : the "undesirable" analysis increments are significantly reduced. This study has to go further : choice of the distance and the length of zeroing for various variables and vertical levels.

The next steps are expected to be :

- adapting ARPEGE ‘‘SUJBCOSU’’ to an ALADIN ‘‘SUEJBCOSU’’ and assessing the impact of compactly supported correlations in the ALADIN 3d-var analysis ;

- introducing dynamics into an academic model and studying the growth of forecast errors in a LAM and its coupling model (using a 1d shallow-water model, for instance).

4. Jean-Marcel PIRIOU : "Correction of compensating errors in physical packages; validation with special emphasis on cloudiness representation"

EUROCS project :

The wet prognostic TKE (Turbulent Kinetic Energy) scheme developed by Pascal Marquet has been introduced in the ARPEGE/ALADIN SCM. Some tests with this prognostic TKE were performed on the diurnal cycle of the PBL over desert areas. A case of diurnal cycle of deep convection over land was studied within the ARM /GCSS /EUROCS framework. Hovmöller diagrams of the diurnal cycle of ARPEGE precipitations in the Tropics were compared to the results from Yang and Slingo (*MWR* 2001). This was presented at the EUROCS workshop in Madrid, in December.

CLOUDNET project :

Write-up with Damian Wilson (Met-Office) of a paper "user requirement document" to explain to the observational community the expectations of the modelling community in this project. Modifications of some DDH codes to fit the requirements of the CLOUDNET model database.
Presentation in the CLOUDNET workshop in Utrecht: "How to improve a cloud model's physics from in-situ data like radar and lidars ?"

5. Wafaa SADIKI : "A posteriori verification of analysis and assimilation algorithms and study of the statistical properties of the adjoint solutions"

Wafaa Sadiki spent 3 months in Toulouse last summer, working intensively on her PhD topic with Claude Fischer. She has now left the NWP team and works in Rabat while writing her PhD manuscript, for a scheduled PhD defence in early summer 2003. Here is the summary written by Claude for the 2002 scientific report :

<<• A-posteriori validation tools and tuning of Jb / Jo :

This work has been re-started this summer in Toulouse, keeping a quite simple formulation of the a-posteriori functions. For a reminder, the main diagnostics are : the ratio Jmin/P, the estimated global background error variance rescaling "Sb" (=Jbmin/Tr(KH)) and the estimated global observation error variance rescaling "So" (=Jomin/Tr(Ip-HK)).

The main results so far:

- There is a clear need to compare the a-posteriori results with independent diagnostics (such as explicit statistics on the innovation vector), in order to have a more in-depth understanding of the possible misfits between modelled and real error statistics. Indeed, it appears that too many ingredients (possible misfits) enter these diagnostics so that extra knowledge is needed for the understanding. For example, Wafaa is now comparing her results with the output of a Lönnberg-Hollingsworth method for auto-covariances, for comparison of both variances and correlation length-scales.
- There remains a fundamental difficulty in assessing the amount of scale-selective error variances, since the innovation vector which is involved in the a-posteriori validation contains all the scales. A scale-selective approach could be a possible future direction of research, for a potential candidate.
- The diagnostics exhibit clearly case-dependent behaviours, which indicates that the error statistics in the LAM are sensitive to weather systems (e.g. synoptic storm inside the ALADIN domain, anticyclonic state, ...)
- A posteriori validation apparently can be used for retuning of statistical parameters, although the work with real data obliges one to depart from the strict theoretical framework and imagine tractable, pragmatical applications. For example, the perturbation method to compute the "Trace" operators demands to aggregate daily datasets together, and to verify afterwards that the (neglected) time-correlations do not spoil the results too much. Also, one needs to assess the stationnarity of the diagnostics over the period of aggregation, which in practice means that the diagnostics are more like monthly climatology. >>

6. Filip VANA : "The dynamical and physical control of kinetic energy spectra in a NWP spectral semi-Lagrangian model"

The work on "semi-Lagrangian horizontal diffusion" (SLHD) restarted, in collaboration with Rok Glavac-Sah (see also the Prague ALATNET report).

Basically from the user's point of view the scheme is ready to be used for current resolutions. The acceptable degree of quasi-independence of SLHD to time-step and horizontal resolution has been confirmed. Thus there are no obstacles to use the scheme within the range of 8-30 km of horizontal mesh-size. On the other side, there are not too many benefits from this scheme on such scales. This can be revisited for mountain regions where it performs better, or once some pure gridpoint prognostic variable will be introduced in the model.

The intention is now to go a bit further, i.e. to test with horizontal mesh-sizes of 2.5 km. Thus the scheme has been implemented as well for NH dynamics and the next step now is to repeat the ALPIA tests with it.

The scheme is not yet available in any ALADIN library, for dynamics is evolving quite rapidly (predictor-corrector approach, new NH variables, etc). Hence phasing will be performed only after the final evaluation of the scheme.

A paper has just been submitted to *Ocean-Atmosphere* : "Semi-Lagrangian advection scheme with controlled damping - An alternative way to nonlinear horizontal diffusion in a semi-Lagrangian numerical weather prediction model" (by Filip Vana, Pierre Bénard and Jean-François Geleyn), with the following abstract :

<< A nonlinear horizontal diffusion scheme using damping abilities of the semi-Lagrangian advection scheme interpolators is proposed. The behaviour of the scheme is tested in the framework of idealised 3d experiment by a statistical model. Then the scheme is introduced to the spectral LAM model and adapted for the real atmosphere with a typical resolution for current operational regional models. Finally the performance of the proposed scheme is examined by parallel test and for case studies compared with the spectral linear diffusion. >>