ALADIN work plan for 2004
In the field of data assimilation
By C. Fischer
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As a consequence of the two Prague workshops about the Aladin/Arome interaction in the coming years, and to start with the work plan for 2004, this proposal tries to take into account the "old" Aladin scientific targets, and related activity, but already "convolutes" it with the Arome-linked initiatives. In the field of data assimilation, there has been an early recognition that the tools and methodologies chosen for the 100-20 km resolution (global IFS and Arpège) can generally talking be downscaled to 10 km (Aladin-1) and below (Arome). Indeed, all these projects will focus on variational, incremental techniques, and they might (or not, but depending on so far unpredictable scientific performances) give raise to new assimilation methods around improved 4D-VAR (for instance, with microphysics), ensemble-based techniques (EKF, ETKF,…), exotic observations (reflectivities, precipitations, GPS,…). The reasons for the wide range of common scientific and technical issues probably are various, but at least two of them are worth to be mentioned. Firstly, data assimilation based on optimal control as well as ensemble techniques heavily rely on the specification and/or estimation of error statistics (forecast model, observations, physical constraints). The specification of these error statistics is limited by a number of shortcomings, that make their practical estimation generally rather crude, as compared to the desired precision of the deterministic forecast itself (one usually is not happy with a displaced or absent cyclone in the "actual" forecast). Some of the shortcomings are: lack of dense and good-quality measurements to compare with, too big phase space (10^7 for observations, 10^6 for model), sampling errors, common use of Gaussian error models and linear error propagation. Misspecification of error statistics is a general plague, at whatever scale the associated assimilation and NWP system is supposed to be operated. Secondly, data assimilation requires a significant manpower effort on upstream developments, such as transmissions, database, observation monitoring and quality control, along with a wide spread of scientific skills (NWP in its forecast component, linear algebra, knowledge of observation properties, management of complex operational suites). Thus, the definition of several, very different, development projects in this field, inside a very same NWP Center, probably is outside of range (the building up of the Aladin 3D-VAR using the IFS/Arpège software as backbone is a striking example of an economic "re-routing"). The main move when comparing the present and future Alaro/Arome interaction with the Aladin-1 scientific plan concerns the departure from the time-continuous TL/AD models (and associated "quick" step towards 4D-VAR in the LAM), towards a more observation-oriented and space-continuous approach (3D-FGAT at full LAM forecast resolution). Furthermore, this plan tries to take into account the very recent take-off of LAM predictability issues, though these aspects are still a matter for more coordinated work in 2004. The document merely tries to list the known project in the LAM/EPS area.

The following documents have been used in order to prepare this plan: GMAP plan of activity for 2004 (F. Bouttier), LACE D.A. work plan for 2004 (G. Boloni), Status at end of October 2003 of the 2002-04 Aladin medium-term research plan (D. Giard), a personal Table prepared in order to mirror Aladin versus Arome topics and manpower (appended). The work plan has been submitted for reviewing to G. Boloni, R. Brozkova, R. Ajjaji, F. Bouyssel, L. Berre, E. Gérard. The author is grateful for their

careful reading, and furthermore apologizes for the number of spelling mistakes with Central European accentuation.

1. Algorithmic aspects

As a preliminary remark, the author would like to stress a more personal feeling: given the likely increase of demand in technical development in the frame of the IFS/Arome general variational software (new control variables, observation operators, maintenance), the Aladin community will probably lack the required trained manpower. By "trained", both the scientific awareness and the technical skills are addressed. Just like in the NH dynamical core, a reasonably large number of trained Aladinists should create a core group for scientific-technical issues, such as introducing an extra gridpoint 3D variable into the control of the IFS/Arome system. Put into different words, it is felt that more scientists should take the step from case studies towards in-depth coding and criticism (!).

a. General maintenance

The demand for the general maintenance, which encompasses the code phasing (twice per year) and the new technical testing, is evaluated at about 36 men.week (2 phasers twice per year for 6 weeks, plus 2 developers over 6 weeks) per year. This amount has so far not been reached, at the expense of technical testing (phasing of 3D-VAR could be achieved more or less comfortably, but new technical options were almost ignored since 1999).

- Validation in CY28 and CY28T1: C. Fischer, G. Boloni
- Phasing to CY29: C. Fischer+?
- New humidity control variable: L. Berre, G. Desroziers, C. Loo (imported from the IFS)

b. Quality control

- VarQC instead of/in addition to screening: P. Moll

c. Time dimension

4D-screening is now a stable and validated configuration of the LAM screening, thanks to the initial efforts by V. Guidard and C. Fischer. This configuration could be associated with a simple 3D-VAR, to test a global minimisation using the time-adjusted innovations. However, no precise plans to further use this combination have been set. 3D-FGAT in the minimisation is a required tool for the Arome feasibility, and should be part of the Aladinists' endeavour for Alaro/Arome. The initial plan to develop 3D-FGAT in coordination with the LACE activities has failed, in 2003. Therefore, we will resume this work in 2004 in Toulouse. 4D-VAR is not on the schedule for 2004, and therefore the announced goal to have a "4D-VAR in a nutshell" by the end of the 2001-2004 mid-term science plan will be missed. However, given the overall activities and goals in the data assimilation group, this missing should not be considered as a dramatic one.

- 3D-FGAT: C. Fischer, C. Soci

d. TL/AD models

More annoying than the missing 4D-VAR is the future of the TL/AD models. Very little manpower has been dedicated to their further development, and one may say, compared to the 1995/1997 period, that these configurations have become marginal. While the SL version is now the Arpège/IFS reference, Aladin still uses only the Eulerian code. The new NH dynamics totally ignore the TL/AD models, and it is now clear that the efforts by M. Charron and C. Fischer to develop and maintain a NH TL/AD version will be lost in the short range. The Aladin project should however keep a firm will to preserve the hydrostatic kernel of TL/AD, and port this one to SL dynamics.

- SL TL/AD: C. Soci, C. Fischer, K. Yessad (all to be confirmed) – start the technical evaluation, for a real coding rather in 2005
- NH TL/AD: put into sleep
- Evaluation of TL/AD model behaviours: C. Soci (completion of Alatnet work by a Romanian PhD and paper in preparation), A. Simon (sensitivity to some physics parameters, also Alatnet)

e. Minimizers

With the firm decision to move to Mike Fisher's CONGRAD minimizer in Arpège (actually become operational on January 29th, 2004), it is safe to also consider this tool for the LAM 3D-VAR. HMS has declared its interest, and would dedicate one newcomer, with a mathematical background, to the testing of CONGRAD in Aladin. This topic will be therefore coordinated with the ALGO team.

- CONGRAD: one person from HMS, G. Desroziers, K. Yessad

f. Model imbalances, initialisation and the "Jc-dilemma"

- Diagnostics and survey: C. Fischer, D. Giard

2. Cycling

The exact choices for the scripts and algorithms for cycling the 3D-VAR analyses will be strongly site-dependent. This situation is probably just as much due to scientific constraints (amount and type of available observations, domain size) as to the "human factor" (believers of a mandatory large scale explicit update versus defenders of as many observations as possible). Therefore, the work around cycling is mainly driven by local considerations, and we might consider that the choices for the assimilation cycling will also in the coming year give rise to discussions, more or less simple inter-comparisons, and mainly exchange of experience.

a. Analysis-only

- cycling of 3D-VAR in the Aladin/Hungary model: more sensitivity experiments (Jb, explicit blending), further testing in an internal e-suite
- "minimal" version of an Aladin/France 3D-VAR assimilation cycle: C. Fischer, plus impact of denser aircraft and ATOVS data taken from the Arpège dataset (with E. Gérard)

b. Large scale update

- DF-blending as "assimilation without observations": Aladin/CZ (former LACE setup)
- Explicit, spectral blending: Aladin/Hungary (S. Alexandru, H. Toth), comparison with BlendVar (D. Klaric, R. Brozkova) on LACE test cases
- BlendVar: Aladin/NORAF (R. Ajjaji, Z. Sahlaoui, F. Hdiddou), MAP/IOP14 (paper in preparation by Guidard & Fischer)
- Variational control towards the Arpège analysis: add an extra term to the cost function (V. Guidard)

3. Background error covariance modelisation

a. Sampling

- ensemble: L. Berre, M. Belo-Pereira (in Arpège, Alatnet PhD), S. Stefanescu (in the Aladin/LAM context), V. Guidard (for cross-comparisons with Arpège analysis statistics)
- NMC-derived: L. Berre (Aladin/France contact), T. Montmerle (AMMA2000 tropical B)

b. Tuning

- further tuning of Aladin/France B statistics: L. Berre, B. Chapnik
- completion of a posteriori diagnostics and retuning for Aladin: W. Sadiki (completion of her PhD work and paper submitted to Tellus)
- comparison with a Loennberg-Hollingsworth approach: G. Boloni, K. Horvath

c. Structure functions

The present structure functions are the bi-Fourier equivalents of the spherical harmonics decomposition, under the assumptions of isotropic and homogeneous correlations. It is so far difficult to assess how long these deeply rooted assumptions will be kept. While the ongoing testing of the LAM 3D-

VAR at higher and higher resolution and with dense observation networks all are likely to pinpoint shortcomings of the structure function representation, it is however not straightforward to develop a drastically different approach. The wavelet work probably offers the only drastic alternative so far, but is still a matter of upstream research. Compactly supported correlations, perhaps rather expressed in a rectangular truncation and only for univariate components, might be a softer alternative, along with the inclusion of off-diagonal terms. The questions that might well raise from the now starting evaluations are various, and it is difficult to guess an order of priority: bi-periodic wrap-around (a deficiency that we suppose to cure partially in future), more flexibility in the B matrix parameters, univariate versus multivariate humidity analysis.

- Bi-periodic increments, compactly supported correlations, isotropy of B: G. Boloni, C. Fischer, L. Berre, V. Guidard
- off-diagonal terms in B: L. Berre, S. Stefanescu
- tuning of the multivariate humidity analysis: G. Boloni, R. Randriamampianina, L. Berre
- beta-plane: L. Berre, R. El Ouaraini
- wavelet basis : A. Deckmyn, L. Berre
- evaluation via single-obs experiments: K. Horvath (Budapest work), L. Auger (in the diagpack spirit)

4. Observations and observation operators

Work around observations is taking off since two years. Two factors can explain this favourable evolution: the possibility to run local variational configurations, along with local observation database handling and data pre-treatment (Casablanca, Budapest, Prague), the further input provided by Arome in terms of manpower (MSG, radar) and technical goals (the absolute need to defend the benefit of the Arome assimilation by the usage of new observations). Obviously, the fact to have now Aladinists concentrating on observations draws part of our "variational manpower" away from the traditional Aladin topics (especially TL/AD and algorithmic aspects).

- ATOVS (AMSU-A, AMSU-B, HIRS) – E. Gérard, R. Randriamampianina, R. Szotak, Z. Sahlaoui (+SSM/I(S)), N. Fourrié
- MSG SEVIRI – T. Montmerle (both impact of radiances and wind data in Aladin), R. Randriamampianina (start MSG retrieval in Budapest)
- AIRS: M. Dahoui, N. Fourrié, T. Auligné
- Use of AIRS data over land : M. Szczech (Alatnet PhD work), F. Rabier
- MSG clear-sky radiances and cloud-track derived winds: inter-comparison and possible complementarity (Czech team)
- Radar: M. Jurasek + P. Moll (Jo), D. Banciu (obs/physics interaction), R. Zaaboul and S. Kertesz ? (ODB), E. Wattrelot, E. Bazile (further involved are F. Bouttier and V.

Ducrocq, as scientific supervisors to O. Caumont, for the actual observation operator specifications)

- Humidity bogusses : F. Hdiddou (specific dataset for testing, with M. Nuret)
- Ground GPS: H. Brenot, V. Ducrocq
- Screen-level data in the Aladin/France assimilation: P. Moll (Toulouse), M. Majek (Budapest)
- Wind profiler data: R. Szotak (Budapest)
- AMDAR data: G. Csima, R. Randriamampianina, student (Budapest)
- Impact of QuikSCAT data in Aladin (C. Payan)

5. Surface analysis

The trend here is to leave the old, but yet celebrated (via diagpack), surface OI analysis provided in CANARI, and go towards a panel of alternative solutions: retrieve ECMWF or EUMETSAT surface analysed data (for snow, SST,…), externalise the ISBA model and analysis components, continue the 2D-VAR development for soil temperature and soil water. It is less clear whether the "screen-level" analysis (T2m, RH2m, U10m) will be part of an external OI-type of analysis, or part of the 3D-VAR analysis in the medium to long range. Work has started to compare the 3D-VAR with diagpack OI, using the French surface mesonet data network (L. Auger). This evaluation will continue throughout 2004.

The specific work around the smoothing of the soil wetness index is completed (S. Ivatek-Sahdan). Work on the snow analysis in CANARI can be resumed by any Aladin partner who is interested and who does have a good local coverage of snow data.

- 2D-VAR continuation: K. Bergaoui (anticipated PhD work on the assimilation of infra-red brightness temperatures to initialise the soil water content), F. Bouyssel
- extraction, and impact of EUMETSAT high resolution surface datasets: SST, snow, albedo, ice (F. Taillefer)
- use of snow analysis for T2m forecast, compare several snow products: H. Toth

6. Latent heat nudging

- implement latent heat nudging from observed precipitation amounts (radar or satellite): G. Gregoric, N. Pristov

7. "Varpack"

The goal of this work is to assess the behaviour of the present 3D-VAR for analysing surface, high resolution data, typically from a dense mesoscale network of SYNOP and automated stations, providing T2m, RH2m and U10m observations. CANARI OI is now a rather successful tool which allows for a clever (in the sense that it uses optimal interpolation as the mathematical background) reshaping of near-surface

fields according to dense observations. This tool has become "diagpack". The idea now is to move this facility into the variational context, first by assessing what is presently possible. This study might well indicate constraints or specific needs for the 3D-VAR algorithm to perform a genuine "nowcasting" analysis. The initial work will consist in carefully studying the response of the Aladin/France 3D-VAR to the mesonet data, perform single-obs experiments of screen-level data, and compare with the output of "diagpack" (L. Auger).

8. LAM predictability

This topic is the new "hot spot" for LAM systems. In the general sense, a LAM ensemble can provide several types of connected information: ensemble-derived B matrix sampling, sets of possible model trajectories for the forecasters, stochastic evaluation of the control model certainty. To trigger the imagination from of-the-state knowledge, an ensemble, if realistic enough (wide spread, large size, good climatological resolution), could be the backbone algorithm for an extended Kalman filter, with online a priori estimation of B statistics and perhaps a posteriori validation of B/R.
LAMEPS projects have started (SRNWP initiative coordinated by DWD, Spain, Norway/Hirlam activities, UKMO ETKF project), and the Alaro/Arome community will be present both with Toulouse work and partner projects (see below).

- Aladin/France EPS: J.-M. Lepioufle, J. Nicolau, L. Berre
- Ensemble Kalman filter : participation of Y. Wang and ZAMG colleagues
- Aladin/Hungary LAMEPS project : S. Kertesz, E. Hagel, G. Szepszo, G. Radnoti. More details about the Magyar plans :
    a. Optimise global SV to initialise the LAMEPS
    b. Force LAMEPS by perturbations from the French PEACE
    c. Evaluate local LAM SVs
    d. Develop and/or install diagnostic and performance products

9. Appendix: synoptic overview of topics and manpower; "mirror" view for Aladin/Arome. Concerns only Var. D.A.

TOPIC	**General dates desired for development and completion**	**Les noms des Français**	*Buffer zone*	**The names of the foreigners**	**Specific dates in any Center (TLS, PRA, BUD, CAS)**	**NOTE**
			Jb			
Jb beta-plane	09/03-01/04	L. Berre		R. El Ouaraini		
Definition of k* and isotropic assumption		L. Berre C. Fischer		G. Boloni	2003-04	

Jb non-diagonal, anisotropic		L. Berre		S. Stefanescu		Romanian PhD topic
Ensemble Jb	Start in summer 03	L. Berre	Transfer experience from Arp to Ald/Aro	M. Belo-Pereira S. Stefanescu		Keep contact ith the HIRLAM community – impact of coupling
Compactly supported correlations	11/02-04/03	V. Guidard C. Fischer				Available in AL26T1
Wavelet Jb		L. Berre		A. Deckmyn		
A posteriori validation		C. Fischer	Shall this topic be continued ?	W. Sadiki	2003	PhD manuscript in preparation; paper submitted
Relocation of any B	Version 0 ready; further improvements depending on progresses on the native B of Ald/Aro	F. Bouttier	Are Aladinists interested by this facility ?			
3D-VAR in assimilation mode						
Screening & 3D-VAR validation	AL26T1 ok	C. Fischer		Many Aladin members during phasings		No ODB without D. Puech …
Assimilation scripts		G. Jaubert F. Duret				Site dependent
Cycling in assimilation: BlendVar-like		V. Guidard C. Fischer		G. Boloni R. Brozkova A. Dziedzic H. Toth	Since 2001	
Ibid for Aladin/NORAF				R. Ajjaji Z. Sahlaoui F. Hdiddou	Since early 03, oper expected by end of 03	
Setup a 3D-VAR cycle (no blending)				S. Alexandru G. Boloni A. Horanyi	2001-spring 03	Alatnet PhD topic of Steluta

Explicit spectral blending in assimilation mode in Budapest				S. Alexandru G. Boloni A. Horanyi H. Toth	Fall 03	Alatnet PhD topic of Steluta
Include the idea of blending in the variational formalism	08/02-07/04	V. Guidard C. Fischer				French PhD topic of Vincent
Evaluate spin-up at 2.5 km resolution; coupling strategies	03/03-06/03	F. Duret				Arome feasibility
Evaluate impact of 3D-VAR at 2.5 km & hybrid assimilation	2003-2004	GMME (test cases)				Arome feasibility
3D-VAR in diagnostic high-resolution mode ("varpack")						
Compare 3D-VAR HR high density with Diagpack	2003-2004	L. Auger				HR data impact studies; structure functions
Tools in variational						
3D-FGAT	2003	C. Fischer		C. Soci	Spring 2004	4D-screening ok in AL26T1
TL/AD models (both HS & NHS)	Continued technical job	C. Fischer	Rather heavy to maintain for a quite uncertain use	Mostly: Cornel, Occasional phasers		Only adiabatic and Buizza configurations are maintained "mitraillettely"
Behaviour of TL/AD models, including simplified physics from Arp	01/01-06/03			C. Soci (A. Simon)		Alatnet PhD topic; manuscript in preparation + paper in Idojaras + paper planned
Towards 4D-VAR				R. Ajjaji		PhD topic on multiincremental in Arpège
CONGRAD minimizer	2004-05	G. Desroziers K. Yessad		Hungarian colleague		Evaluate in LAM 3D-VAR
Interaction with the surface						
BlendCan or CanBlend				A. Dziedzic		
Observations						

Screen-level obs (T2, RH2, U10)	2003-…	P. Moll L. Auger (varpack)		M. Jurasek K. Horvath	Several stays in Prague, Toulouse and Budapest	
Temp		GMAP basic usage		Also backgd 3D data in Casa, Prague, Budapest		
ATOVS like in Arpège		E. Gérard		R. Randria. Z. Sahlaoui		AMSU-B
SSM/I(S)		E. Gérard		Z. Sahlaoui		
				M. Dahoui		French PhD
ATOVS, AIRS, …				N. Fourrié		CNRS
Meteosat-type radiances (MSG Seviri)	09/01-10/03	T. Montmerle		M. Irsic ?		Arome development
Boguses of humidity profiles (“Humsat”)		M. Nuret V. Guidard		F. Hdiddou		
Radar obs operator		E. Wattrelot O. Caumont		M. Jurasek D. Banciu R. Zaaboul S. Kertesz (?)		Arome development
Radar pre-treatment and quality control		?		?		
Radar data impact study	08/03-07/05	V. Ducrocq F. Bouttier O. Caumont				French PhD
Ground GPS		H. Brenot V. Ducrocq				
ODB						
System maintenance, installation and survey		D. Puech		S. Kertesz S. Ivatek-Sahdan R. Zaaboul		
