THIRD MEDIUM-TERM (2002-2004) RESEARCH PLAN FOR ALADIN

« marching towards
very high resolution and continuous data assimilation
while preserving if not improving
the current level of response to operational problems »

WHAT'S NEW ?

an old (10 years) and mature (?) project
+
less external financial support

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a new organization of research is required !

- increasing responsibilities for each partner
- a higher part of local research
- a more intensive networking

a research plan elaborated through
a close cooperation between all partners

TRAINING

- ➢ Local basic training : the present effort must be preserved
- ➢ Advanced training : alternative solutions are to be designed
- ➢ PhD theses : all partners must be aware of their importance for local research & training

ALADIN / ALATNET PhD theses

defended :

1995 :	Radmila Bubnova (CZ),	Elena Cordoneanu (RO)
1996 :	Mihaela Caian (RO),	Andras Horanyi (HU)
1997 :		
1998 :	Marta Janiskova (SK)	
1999 :		
2000 :	Mark Zagar (S I),	Ilian Gospodinov (BU)
2001 :	Doina Banciu (RO),	LoÏk Berre (FR)
	Francois Bouyssel (FR),	Luc Gérard (BE)

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in progress :

AU :	Klaus Stadlbacher		
CZ :	Martin Janousek,	Filip Vana	
FR :	Jean-Marcel Piriou		
IT :	*Gianpaolo Balsamo*		
MO :	*Radi Ajjaji,*	*Wafaa Sadiki*	
PL :	Malgorzata Szczech		
PT :	Margarida Belo-Pereira		
RO :	Steluta Alexandru,	Raluca Radu,	Cornel Soci
SK :	André Simon,	Jozef Vivoda	
TU :	Karim Bergaoui		

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MAINTENANCE

ESSENTIAL FOR THE LIFE AND PROGRESS OF THE ALADIN PROJECT

INCLUDING :

- phasing,
- optimization,
- documentation,
- a few other technical tasks of common interest

EMERGING PROBLEMS !

- increasing part of data assimilation ⇒ heavier phasing
- maintenance of scripts
- very (too) large discrepancies between local versions
  ⇒ efforts required from local teams and also from the Toulouse one
- increasing portability problems

EWGLAM/SRNWP initiative for common model interfaces

OPERATIONS

Main objectives,

to be further discussed after the technical overview of the project

- reduced discrepancies between local versions
- harmonized operational schedules (forecast, assimilation)
- extended production of coupling files (frequency, range, assimilation, ...)
- implementation of local databases for observations
- exchange of local observations between partners

(no longer any transmission of full observation files from Météo-France !)

APPLICATIONS

POST-PROCESSING :

- ♣ forecast : new fields on demand
- ♦ research configuration (assimilation) : implementation

AVAILABLE TOOLS FOR OPERATIONS AND RESEARCH :

- ♠ re-launching the exchange of applications
- ♦ ensuring portability
- ♦ design of a management procedure

INTERFACE TO DOWNSTREAM APPLICATIONS :

- ♦ documentation of existing tools

STATISTICAL ADAPTATION

- ♦ more networking, within ALADIN and SRNWP

DYNAMICAL ADAPTATION

- ♠ further research required

MODEL TO SATELLITE APPROACH

- ♣ a recent and promising tool

DIAG-PACK

- ♦ enhanced exchanges with nowcasting teams
- ♦ further research required

VERIFICATION

« This point is not exactly a topic of research but is to be mentioned here since it provides the basis for the definition of priorities. ***Routine subjective and objective verification, including the comparison to observations, to other ALADIN models, to other forecasting systems, and between operational and test suites, is crucial to track deficiencies and steer further developments.*** *»*

(Second medium-term research plan)

<u>BUT THIS TOPIC IS NEARLY AT THE SAME POINT AS IN 1999 !</u>

Building a coordinated procedure for objective verification at synoptic scales	Definition of rules, implementation of the database Routine update of the database Improvements and diffusion of results
Defining a verification procedure for high resolution forecasts	Definition of a working group, involving modellers and forecasters Use of satellite and radar data (precipitations) Safe exchange of local observations between ALADIN partners

COUPLING

An emerging priority :

- severe operational failures (1999 Christmas storms)
- results from sensitivity studies based on variational tools (to prepare 4d-var)
- results from case studies at very high resolution

Interaction with orography	"Surface-pressure tendency" coupling "Orography" coupling
Spectral coupling	Use of large-scale spectral information Interpolation of amplitude and phase-angle Combination with Davies'scheme Case studies and tuning
Time-interpolation	Further comparison of the present schemes
New prognostic variables	Design of a strategy for new variables from physics Introduction whenever required
Towards higher resolution	Pseudo-radiative scheme Two-way nesting Non-hydrostatic variables Case studies
Choices for data assimilation	Comparison of present choices Spectral coupling and 4d-var

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DYNAMICS

Hydrostatic dynamics : improved semi-Lagrangian schemes	Uniformly accelerated scheme Predictor-corrector (P/C) scheme
NH dynamics : three-time-level semi-Lagrangian (3TL) schemes	Optimal choice of model variables P/C scheme
NH dynamics : two-time-level semi-Lagrangian (2TL) scheme	Properties of P/C scheme Refinement in the choice of model variables Use of decentering
Bottom boundary condition (NH) & related discretisation problems	Optimal discretisation General improvement of the current scheme
Diabatic forcing)	Strategy for the diabatic forcing Adaptation to the final choice of prognostic variables (NH)
Orographic forcing	Optimal filtering of the orography Resonance problem in NH
Relaxation of the thin layer hypothesis	Implementation and test in ALADIN Extension to NH
Radiative upper boundary condition	Feasibility study : analysis, academic 2d tests Adaptation to ALADIN NH Control of the hydrostatic version
Horizontal diffusion	Horizontal diffusion using semi-Lagrangian interpolators Gridpoint treatment of humidity

--- high priority, important and/or urgent action
--- intermediate priority or "medium-term" action
--- low priority or "long-term" action

PHYSICS

Solving identified problems at the present operational resolutions & Going towards higher resolution : ~ 5 km

USE OF NEW PROGNOSTIC VARIABLES AND CHANGES IN CONCERNED PARAMETERIZATIONS	Convection	Introduction of a prognostic convection scheme Management of the 4 new variables Validation over an extended set of situations Investigating problems in the triggering of convection Analysis of the closure and hysteresis problem
	Microphysics	Management of 2 or 3 new variables : condensed water Further analysis of the "Functional Boxes" approach Introduction / choice of a semi-complex microphysics Interface with convection Prognostic treatment of falling condensates or not?
	Vertical diffusion, low cloudiness, PBL, ...	Introduction of a prognostic TKE scheme (1 new variable) Interaction with other developments concerning PBL : * link between top of PBL fluxes and cyclogenetic activity * noise in shallow convection * PBL-height dependent mixing lengths * developments in the anti-fibrillation scheme * improvement of low-level cloudiness (diagnostic scheme)
	General problems	Update of thermodynamics Consistency with the other parameterizations Interface with coupling, dynamics and data assimilation Consistency with regular physics Validation at various horizontal and vertical resolutions

IMPROVEMENT OF BASIC PARAMETERIZATIONS	Radiation	Refinements of optical depths Move (choice, development) to an intermediate scheme
	Orography	Improved smoothing of very small scales Management of the extension (and coupling ?) zone Tuning of the envelope Better description of roughness length Investigation of feed-backs with other parameterizations Study of local circulations Development of new diagnostics
	Surface	Parameterization of lakes Improved description of evaporation over sea Revisit of the z0h/z0m ratio over land Improved databases for soil and vegetation

Simplified regular physical parameterizations	Tuning of diffusion Improved description of humidity Validation at high resolution Consistency with the "full" physics

Physics / dynamics interface	Introduction of the new variables Interaction with the predictor / corrector approach Interface with "externalized" parts of the physics

VALIDATION	Case studies	Identification and study of "strange behaviour" cases Selection and documentation of extreme situations Validation on a wider range of situations
	New observations	Comparison to satellite data Comparison to radar or lidar data Interfaces to new field experiments
	New methods	Design of new scores or criteria Use of expert systems to identify fine scale structures

DATA ASSIMILATION : METHODS

Main objectives for upperair assimilation

Prototype 3d-var ➡ Operational 3d-var ➡ Operational 3d-FGAT ➡ Prototype 4d-var

Cautions !

- increased local and centralized maintenance
- management of scripts, maintenance of a reference version
- need for new observations to feed data assimilation systems
- mostly local choices and tunings

Algorithmic aspects

3d-var	Use of observations at the borders of the domain New minimization algorithms Design of an explicit spectral blending and combination with 3d-var Improvement of observation operators (vertical interpolations) Choice of the time-window for the selection of observations
3d-FGAT	Implementation of a 4d screening Choice of lateral boundary conditions Choice of the time-window
4d-var	Maintenance of the TL/AD code (for various research purposes) Coding TL/AD of semi-Lagrangian schemes Definition of coupling strategies for the various elements Adaptation of Jc-dfi (to high resolution, to new variables) Improvement of simplified physics
Simplified physics	Evaluation through sensitivity studies Evaluation and tuning at high resolution Solving incrementality problems Adapting observation operators to new variables
A-posteriori validation	Further tuning of statistics (observations + background) for 3d-var Extension of diagnostic tools to 4d-var
TL/AD tools	Maintenance of the TL/AD code (reminder) Use in the design of the TL/AD code (e.g. LBC, NH, new variables) Use to study nonlinearity problems (e.g. in simplified physics) Predictability studies
Var-Pack	Watch

Modelisation of background / forecast errors

Sampling methodology	Evaluation of the different contributions to error covariances Ensemble analyses and forecasts with perturbed observations Singular vector approach
Diagnostics	Heterogeneity and anisotropy Time-dependence Nonlinear effects
Jb formulation	Approaches based e.g. on diagonal blocks and wavelets
New variables	Taking into account new prognostic variables (NH, cloud water, ...)

Cycling

Blending	Maintenance of a reference version of dfi-blending Adaptation to the main changes in the model Development of double-nested blending Comparison of "dfi" and "explicit" blending for spectral fields
Assimilation cycle	Investigating the various combinations between 3d-var, dfi and blending Combination with surface analysis or surface blending Moving to 3d-FGAT Maintenance of a reference version
Frequency of 3d-Var	Evaluation through sensitivity studies

DATA ASSIMILATION : OBSERVATIONS

Neglected along the last year but more and more essential

The first step, not explicitly mentioned here, is of course the implementation of local databases.

ODB	Maintenance and documentation Development of new tools
Satellite data	IASI / AIRS: Improved description of surface emissivity Raw ATOVS data : use of local data Cloudy ATOVS data : observation operator, Jb GPS SSM/I Profiler data
Surface observations for upperair analysis	From the less difficult or most important ones to new ones: surface pressure, 2m-relative humidity, 10m-wind, ...
Aircraft data	Use of local data
Radar	Winds Reflectivities
Pre-analysed data (or pseudo-observations)	Pseudo-TEMP for relative humidity : case studies Pseudo-TEMP for relative humidity : regular use Surface data bogus
Screening	Evaluation for high-density data New data types Time window Time dimension PBL fields
Space consistency of the quality control	Combination with the use of the CANARI quality control Variational quality control

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DATA ASSIMILATION : SURFACE

Surface analysis is used in two ways :

- ➢ to initialize soil and surface variables (temperature, moisture, snow characteristics, ...) : assimilation purpose
- ➢ to provide an analysed state as close as possible to all available observations : nowcasting purpose

The Optimal-Interpolation version will be maintained for the next three years. The combination with upperair assimilation (within the problems of scripts and coupling) is to be considered at each main step.

Analysis of PBL fields, for : *** Diag-Pack** *** the correction of soil fields**	Retuning of statistics (forecast and observation errors) Geographical dependent error statistics (orography, coasts, ...) Analysis of new fields (precipitations, visibility, cloudiness, ...)
SST analysis	Retuning Use of pre-processed satellite data
Snow analysis	Retuning of statistics, for large and small scales Estimation of the vertical correlations for errors on snow depth Calculation and use of a snow mask derived from satellite data Use of pseudo-observations from local networks Analysis / correction of new fields (albedo) Improved climatological fields
Assimilation of soil moisture and temperature	Reduction of the horizontal heterogeneity of soil moisture Retuning and implementation in ALADIN Combination with dfi-blending Combination with 3d-var Moving to a variational assimilation Use of satellite data Improved climatological fields
Diag-Pack	Improvements in observations operators (vertical interpolations) Use of aircraft, profiler, radar-wind data Diagnostics fields (smoothing, new ones)
Quality control	Retuning screening for surface observations

PREDICTABILITY

Ensemble Prediction Systems (EPS) for Limited-Area Models is an emerging topic.

A large range of solutions may be considered, e.g. :

- Initial state uncertainties sampling, using :
    - ♦ singular vectors,
    - ♦ breeding methods, based on perturbations on the assimilation cycle, ...
- Model uncertainties sampling, using :
    - ♦ a stochastic physics,
    - ♦ several models,
    - ♦ changes in namelist parameters, within a reasonable range of variation, ...
- Perturbed lateral boundaries, using :
    - ♦ several coupling models,
    - ♦ forecasts from a global EPS, ...
- Several LAM with their own lateral boundary conditions, ...

An EPS project focusing on small scales but using ARPEGE has just started.

There is a general agreement on the necessity to investigate EPS with ALADIN, but with a low priority, focusing on :

- defining the aim(s) or requirements,
- keeping a watch,
- performing preliminary case studies (for instance in the framework of a PhD ?)

Note : the cost of EPS is not negligible at all !