CURRENT SCIENTIFIC STATUS OF THE QUASI-OPERATIONAL VERSION OF ALADIN

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I) INTRODUCTION

This factual document is written as a complement to the draft scientific plan, in order to clarify the "starting point" of the latter. It is representative of the quasi-operational situation on June the 17th and includes some ideas about current urgent actions and validation/consolidation plans for the autumn of 1994.

The status report shall be divided into five items of unequal importance referring to the equivalent ones of the draft plan: Lateral Boundary Conditions, Dynamics, Physics, Initialization (as only current data assimilation issue) and Verification.

Before going into more details, and even if all options might be reset at short notice, if needed, let us give here a few figures about the current quasi-operational configuration :

- domain of 205 (EW) x 189 (NS) grid points, centred at 17° E/46.24°N, projected on a tangent Lambert representation with a 18.3191 grid distance on the collocation grid (i.e. size 3737 x 3444 km at equivalent global truncation T728) ;
- full collocation grid of 216 x 200 points, allowing an elliptic truncation with maximum wave numbers 71 and 66 ;
- -24 vertical levels, top one at 10 hPa and bottom one 17 meters above the ground ;
- semi-implicit semi-Lagrangian time stepping ; time steps of 540s for the 36 hour forecast and 360s for the digital filter initialization ;
- eight ranks of Davies-Kallberg coupling ; different coupling functions for moisture and for the other parameters ; coupling within the preparation of the Helmholtz solving ; quasi-isotropic bi-periodicization ;
- physics nearly identical to the ARPEGE one but for a stronger surface roughness and a less stringent reduction of the dynamical humidity convergence feeding the convection scheme ;
- approximate e-folding times of the smallest represented waves in a sixth order spectral horizontal diffusion : 500 s for divergence, 5000 s for vorticity, temperature and moisture ;
- surface fields prepared using an orography that was optimized to diminish the detrimental effects of Gibbs waves ;
- coupling with ARPEGE T119 c=3.5 L24 at a frequency of 6 hours ;
- centred "optimal" digital filter initialization with a 4.6 hours span and cut-off frequencies of 3 and 12 hours ;
- 36 hour forecast from 00 UTC with spectrally filtered (characteristic length of the filter : 130 km, applied only on upper-air-type fields) post processing and "zoomed" graphics on 158 x 110 grid points, every 6 hours.

II) LBCs

The lower boundary conditions of ALADIN (orography, land sea mask, vegetation, ... and estimated monthly climatologies for soil temperature, soil wetness and snow cover at the model's orography height) are obtained from a "E923" configuration that reproduces at the ALADIN scale and in the ALADIN geometry (obtained from the "EGGX" sub-package) the characteristics of the ARPEGE "923" configuration. This configuration has to run only once, each time a new domain is defined.

For each run of ALADIN and each range of coupling between ARPEGE and ALADIN (including the initial one), an ALADIN file describing the model state variable interpolated from a similar ARPEGE file is obtained through one execution of the "E926" configuration. This configuration is the ALADIN equivalent of the ARPEGE "926" configuration. The interpolation program takes into account the preservation of the vertical structures of the initial file (PBL displacement) and the need to introduce features related to the finer definition of orography and land-sea mask in the ALADIN file (weighted interpolation of deviations from the climatologies, respectively created by "923" and "E923"). The "E926" configuration uses the "EGGX" geographical definition and the so-called "bi-periodicization" algorithm. The latter allows to "invent" a solution in the extension zone that has at the same time a high level of compatibility with the solution in the real domain, a good isotropy and a small level of noise. The currently used algorithm is based on a cascade of 1D spline and of transversal smoothing steps ; despite being rather simple and completely heuristic it has been proved to be better than more sophisticated and/or optimized alternatives. The results of the "E926" configuration could perhaps be the subject of the same spectral filtering than that of the post-processing.

The ALADIN code is arranged so that bi-periodicization is only necessary in the preparatory steps that make use of the "E926" configuration. Indeed the model integration is performed as if the dynamics+physics computations were done on the full domain (extension zone included), the results being merged at each time step with a linear interpolation in time between two bi-periodicized "large-scale" states that were obtained, for the time being, at 6 hours intervals. A recently introduced sophistication of these algorithms improves the situation by allowing not to do the unnecessary computations inside the extension zone, even when the semi-implicit option is activated. The coupling depends on the horizontal shape of the merging weights that are equal to one in the extension zone, to zero at some distance of the lateral edges of the domain and show a smooth transition in between (on eight grid-intervals, more precisely). The exact functional dependency of this transition has been optimized (in Eulerian mode) and this tuning resulted in a sharper transition near the edge for moisture than for other parameters. This optimization ought to be repeated soon now that the standard time-scheme is the semi-Lagrangian rather than the Eulerian one. Similarly, more precise options than the linear interpolation in time are under investigation for the instantaneous estimation of the coupling fields themselves.

III) DYNAMICS

The main scientific choices of ALADIN will be only briefly recalled here : spectral computation with a so-called "elliptic truncation" (for isotropy reasons), horizontal diffusion in spectral space, semi-implicit in "correction mode", bi-Fourier representation of the fields (conformal mapping -stereographic, Lambert or Mercator- on a toroid geometry) with the help of an "extension zone" without any geographical meaning, all this following as closely as possible the common parts with the IFS/ARPEGE code (especially for grid point dynamics+physics computations).

The semi-Lagrangian time stepping algorithm is similar to the ARPEGE one but for three important details :

- the implicit plane representation of the fields avoids to treat the earth's curvature problem for trajectories ;
- the regular Cartesian character of the collocation grid simplifies the problem of horizontal interpolations ;
- when going inside the extension zone, the trajectories are stopped at the edge of the domain ; the resulting error in the advection terms is damped through the coupling process (provided the transition zone is wide enough, a fact that was verified empirically for the quasi-operational setting).

The very encouraging first results of the semi-Lagrangian option (computer time saving by a factor three and good meteorological performances) lead to its choice for the quasi-operational introduction with only a minimal testing of several options. This will have to be taken back as subject of investigation as soon as possible as a first step towards a possible two-time-level version. Parallelly a study of the spectra of several fields and of their evolutions during ALADIN integrations should soon be used as input for other tunings, especially concerning the horizontal diffusion.

IV) PHYSICS

Only two retuning of the ARPEGE physics appeared necessary in a first step, owing to the changes in the forcing introduced by the choice of the semi-Lagrangian time-stepping. The land surface roughness has been multiplied by a factor of about 2, in order to compensate for stronger surface winds. The parameter controlling the mesh-size dependency of the reduction of the so-called "convection feeding dynamical humidity convergence" has been relaxed towards heavier precipitation in order to compensate for an inverse effect of the semi-Lagrangian time stepping. It is very likely that both modifications should be applied to ARPEGE when it also becomes semi-Lagrangian in the near future.

The too strong dependency of convective precipitations with respect to geographic type forcings is currently under investigation. The possibility to mitigate such effects by increasing the convective entrainment rate as clouds get more and more shallow appears a promising solution.

In a second step, other systematic errors of the model will soon be diagnosed by running ALADIN on the monthly time scale with observed LBCs and comparing its mean state with that of its coupling fields.

V) INITIALIZATION

The digital filters of ALADIN are supporting several options and the currently chosen one had been optimized in Eulerian mode (no modification of any constraint between the filtering and the effective forecast, backward adiabatic plus forward diabatic with no correction at time zero, optimal filters, ...). The switch to the semi-Lagrangian time stepping created some problems, probably associated to the complexity of vertical trajectories when using unbalanced fields in a forecast with relatively long time steps ; the current solution to these problems is to run the filter part with a time step 2/3 of the nominal one. It is however obvious that a longer term solution (launching, i.e. digital filter for a non zero initial time ?) will be soon necessary to curb this problem and work on that issue has already started.

VI) VERIFICATION

A full package of verification against surface and upper air observations exists and is quasi-operationally activated. It allows to objectively compare ALADIN with its ARPEGE counterpart, since the "coupling fields" issued from the "E926" configuration are post-processed and verified in exactly the same way as the ALADIN forecast fields. However it is yet too early to draw conclusion from the sparse information gathered by these diagnostics in quasi-operational mode.

VII) CONCLUSION

ALADIN is a young model, both through the relatively short time that was necessary to develop it and through its yet very short quasi-operational life, but the preceding paragraphs are hopefully indicative of the tremendous amounts of research/development efforts that have already been invested into it or are still being invested. The possible follow on of these efforts is the subject of the draft research plan to which this paper is appended.