3D-FGAT in ALADIN analysis

Cornel Soci *

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1 Introduction

In autumn 2003, Aladin community explicitly expressed its interest in assessing the possibility of using the 3D-FGAT analysis. Indeed, since for a high-resolution model 4D-VAR analysis is supposed to be prohibited due to the required computer resources, 3D-FGAT can be seen as a viable option and a better solution than 3D-VAR. As developed in ARPEGE/IFS, 3D-FGAT (first guess at appropiate time) combines features from 4D-VAR with those coming from 3D-VAR. For example, the trajectory and the screening of data is performed as in 4D-VAR while the minimisation is close to 3D-VAR (more details in IFS Technical Memo for CY22R2).

The present report briefly describes the experimental framework designed to assess the 3D-FGAT in Aladin analysis. The work is based on cycle CY28T1 of ARPEGE/Aladin

2 Experimental framework

Since the actual operational Aladin/France domain (300x300x41, linear truncation 149) was found to be too computer memory demanding for our purposes, it was decided to use a nested domain in the Aladin/France. In this respect, it was chosen a domain (64x64x41, linear truncation 31) covering the southwest of France, hereafter denoted as FrSud. The climatic file for the experimental domain was created using the tools described in "Rélisation d'un Aladin transportable" by S. Petitcol (COMPAS/GCO) or on the Météo-France internal web page http://irix.meteo.fr/∼mcdi004, column Services/Clims Aladin.

Another important tool used in the setup part of this work was **jbconv** program. This program creates new J_b Aladin statistical file at different resolution and for a domain nested into a larger one for which J_b files (stabal.bal and stabal.cv) have already been created. For diagnosing the structure functions created in such a way, **jbdiag** program must be used. More

* *e-mail*: cornel.soci@meteo.inmh.ro

details about the two programs (and other important tools) can be found in "AROTOOLS User's Guide" written by F. Bouttier et al (2004). Note that for the current version of jbconv, only squared domains are considered.

For assessing 3DFGAT in Aladin analysis, FrSud domain is used as a test bed. In this respect, 2 sets of experiments described in Table 1 are carried out: 1 observation experiment and full observations experiment. Then the results obtained from both sets are compared with the equivalent 3DVAR analysis. The single observation experiments is performed using a 2m temperature at Toulouse (SYNOP type) at 00 UTC. These experiments are labelled a001 and a002 in Table 1. The analysis increments for temperature at model level 41 issued from 3D-Var (Fig.1a) and 3DFGAT (Fig.1b) are plotted for comparison. *The two increments have significantly different values, and this feature certainly requires more attention in the forthcoming validation.* As indicated in Fig.1c, when the obervations (T2m in our case) are available for every time slot of the assimilation window performed with 3DFGAT, the structure functions significantly change their pattern. Also, similar features are found for example, for zonal (Fig.2) or meridional (Fig.3) wind components respectively.

3 Technical notes

During this work, another important task was to study the possibility of storage the trajectory at each time slot and not at every time step. Thus, the expected result would be a significant decrease of the required computer memory during the 3D-FGAT minimization job. For instance, in a001 test (when using FrSud domain) the necessary computer memory was about 1.8 Gbytes, while for 3D-VAR analysis (a002 test), this was about 1.1 Gbytes.

By studying the ARPEGE/IFS code it was revealed that the storing of the trajectory at time steps equals with a multiple of the advection time step (TSTEP) already existed. Indeed, this part of the code could be activated whenever the real variable TSTEP_TRAJ (namdyn) was set to a value different than TSTEP (TSTEP_TRAJ=n*TSTEP; n=2,3,...). In our tests, TSTEP_TRAJ=3600. and TSTEP=400 were used. Thus, for a typical 6-hour assimilation window, during a similar test as a001, the required computer memory decreased to 1.2 Gbytes. In Table 2, the necessary computer memory for 3D-VAR and 3D-FGAT analysis when using the operational Aladin/France domain is presented.

Although the code seems to work rather properly, for ALADIN a different solution should be used. Indeed, TSTEP is only determined by considering the numerical stability during the model integration, and to store the trajectory at every TSTEP_TRAJ as a multiple of TSTEP is a constraint dificult to achieve and to justify for operations. For instance, it was the case when using the operational Aladin/France time step TSTEP=415.385s.

The proposed solution is to utilize the already developed code for storing the trajectory at every TSTEP_TRAJ but to modify the trajectory module so that the storage is done every time slot. To be more specific, under the L3DFGAT key in trajectory module, to set the MSTEPTRAJW/R arrays for being used in agreement with the NTSLVSTST (yomectab) values which are given for every time slot.

Table 1: Description of the experiments performed for assessing 3D-fgat in ALADIN.

Experiment label	Analysis type	
a001	3DFGAT	single-obs (T2m at Toulouse), at 1 time slot (00 UTC)
a002	3DVAR	Idem
a003	3DFGAT	1 obs (T2m at Toulouse), at every time slot
a004	3DFGAT	full obs
a005	3DVAR	full obs

4 ANNEX

If one wants to use the FrSud domain for further experiments or 3DFGAT validation, the necessary files can be found on delage, as follows:

– coupling files :

/cnrm2_mrpa/mrpa/mrpa664/FrSud/cpl

coupl.2004051100.r18

coupl.2004051103.r18

coupl.2004051106.r18

coupl.2004051109.r18

coupl.2004051112.r18

– 12-h forecast

/cnrm2_mrpa/mrpa/mrpa664/FrSud/2004051118/ICMSH*

– Jb statistical files

/cnrm2_mrpa/mrpa/mrpa664/FrSud

stabal96.FrSud.bal

stabal96.FrSud.cv

Output files :

3DVAR : /cnrm2_mrpa/mrpa/mrpa664/cy28t1/e131

3DFGAT : /cnrm2_mrpa/mrpa/mrpa664/cy28t1/e131_4d

Table 2: Requested computer memory for 3D-VAR and 3D-FGAT when using operational Aladin/France domain for full observation experiment.

Analysis type	TSTEP (s)	TSTEP_TRAJ (s)	Total required memory (Gbytes)
3DVAR	-	-	13.6
3DFGAT	400	400	28.3
3DFGAT	400	3600	13.6

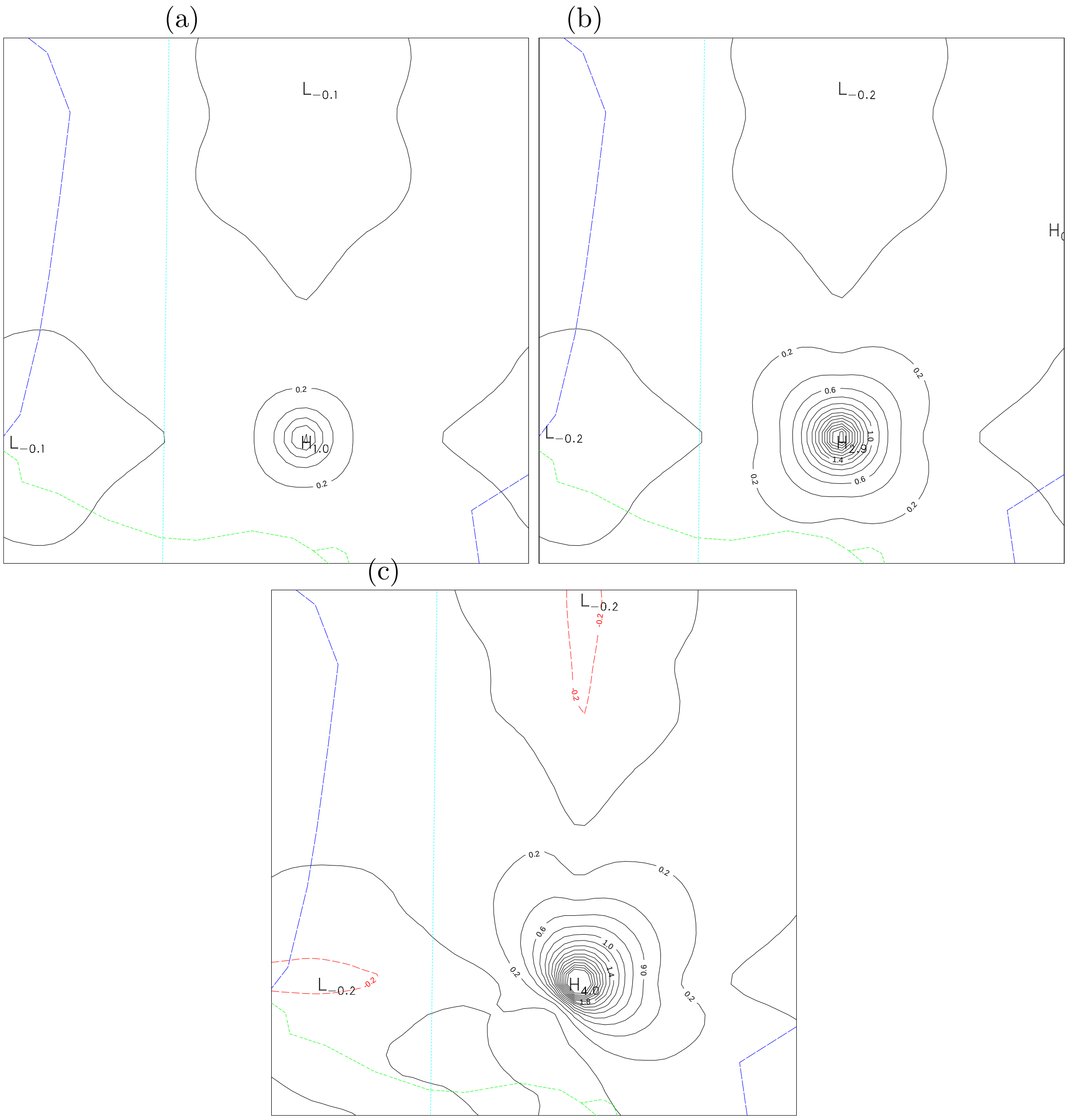

Figure 1: Analysis increments of the single observation experiment for temperature at model level 41 (a) 3dvar (exp label a002 in Table 1), (b) 3dfgat - observation at the same time slot as for 3dvar (a001 in Table 1), (c) 3dfgat with 1 observation at every time slot (a003 in Table 1).

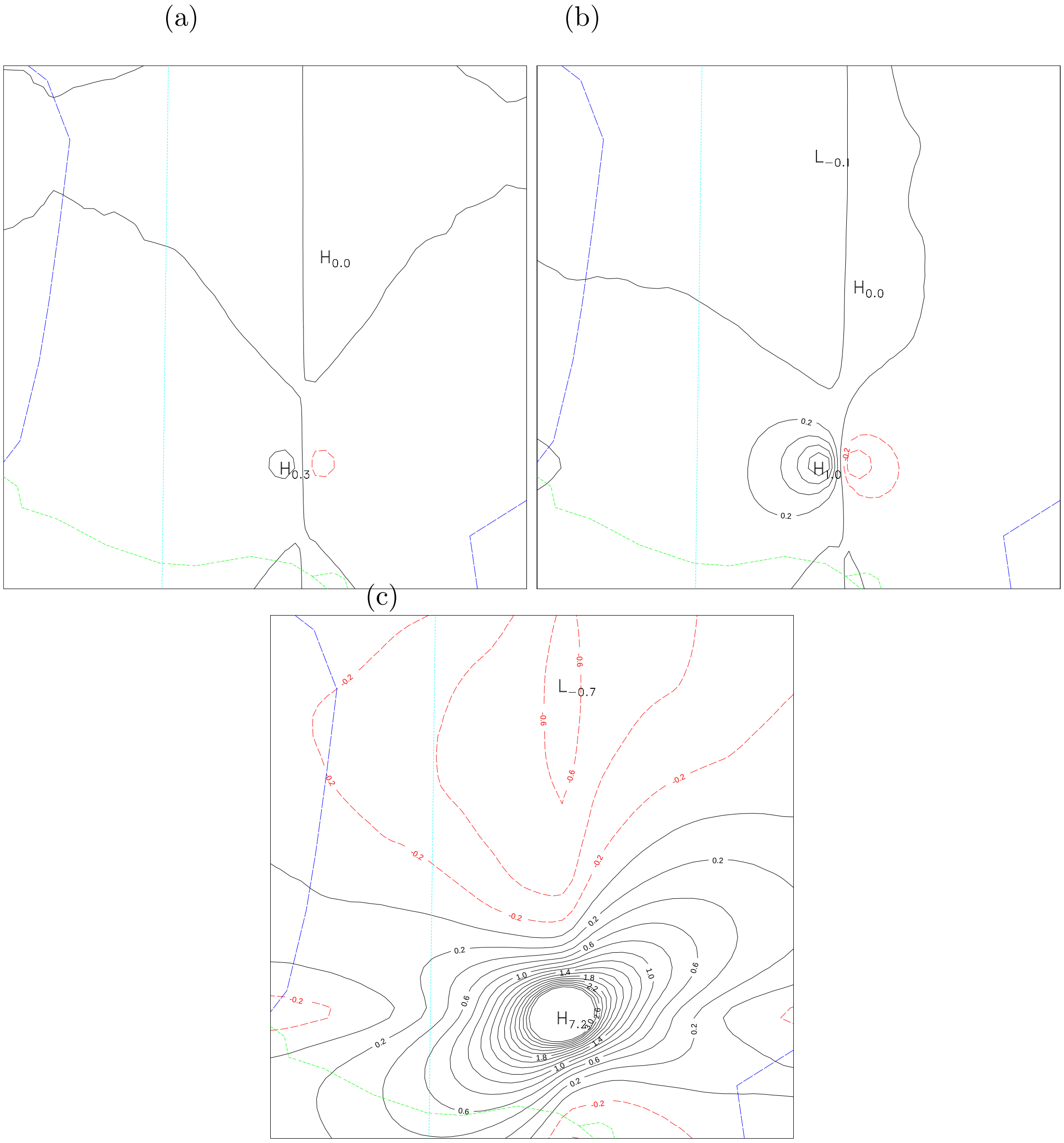

Figure 2: As in Figure 1 except for zonal wind component.

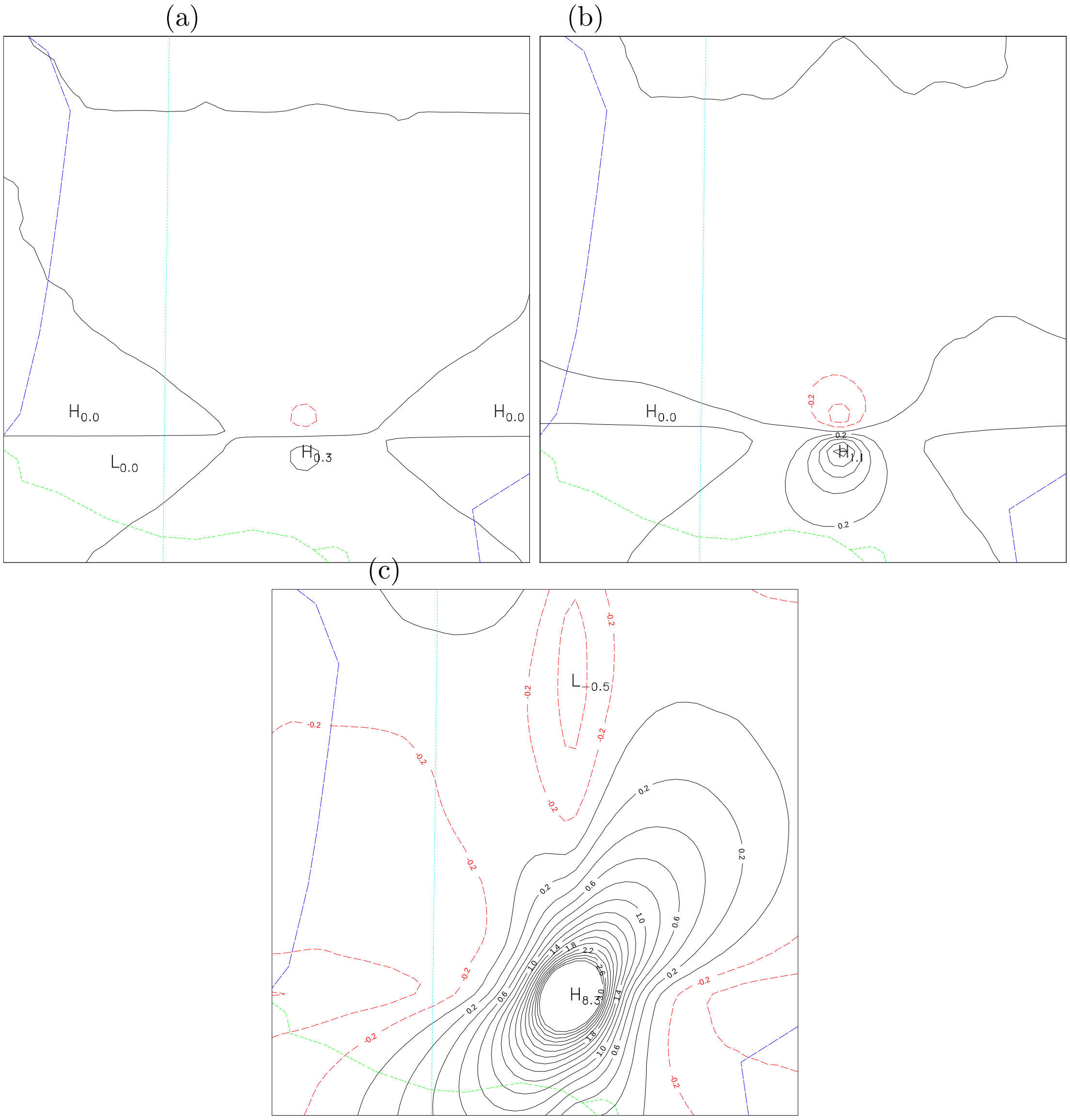

Figure 3: As in Figure 1 except for meridional wind component.

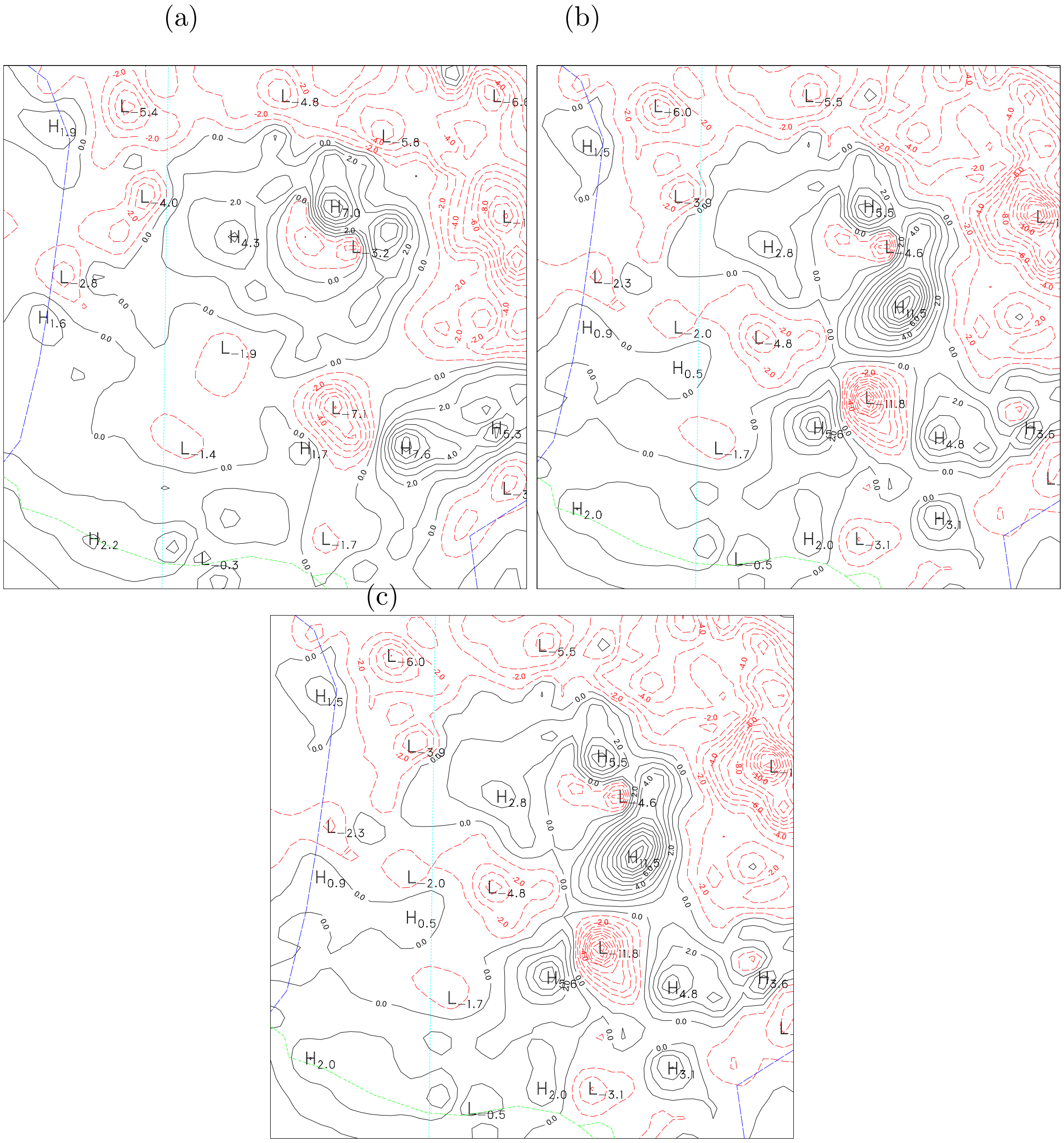

Figure 4: Analysis increments of the full observation experiment for temperature at model level 37 (a) 3dvar (a005 in Table 1), (b) 3dfgat (a004 in Table 1) TSTEP_TRAJ=TSTEP=400s and (c) as in (b) except for TSTEP_TRAJ=3600s. Contour interval every 1.0K.