Spinup properties in AROME

Météo France stay report, October 2008

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1) Introduction

The aim of this stay was to diagnose oscillation patterns in AROME; continuing study about oscillations in AROME which has done by Jure Cedilnik on December 2007; further understand the spin up oscillation in AROME occurring in the lowest model levels and during mostly the first hour of simulation; assess impact of digital filtering on oscillations and forecasts.

2) Experiment setup and case descriptions

All the tests were performed with an AROME France domain (600x512 points, 41 vertical levels, 2.5 km horizontal resolution). Forecast range of AROME was 6 hours.

Echkevo modest by Ludovic Auger was used for producing sequential output of time series for 4 points of the domain which are marked in Figure 1 and specified in detail in Table 1. Two points are on the mountains. Point 1 is on the Pyrenees and Point 3 is on the Alps. Point 2 is over sea and point 4 is on the plain.

Olive swapp environment was used for all the experiment. Experiment names and descriptions are given in Table 2.

The date of initial condition is on September 9, 2008 at 00 UTC.

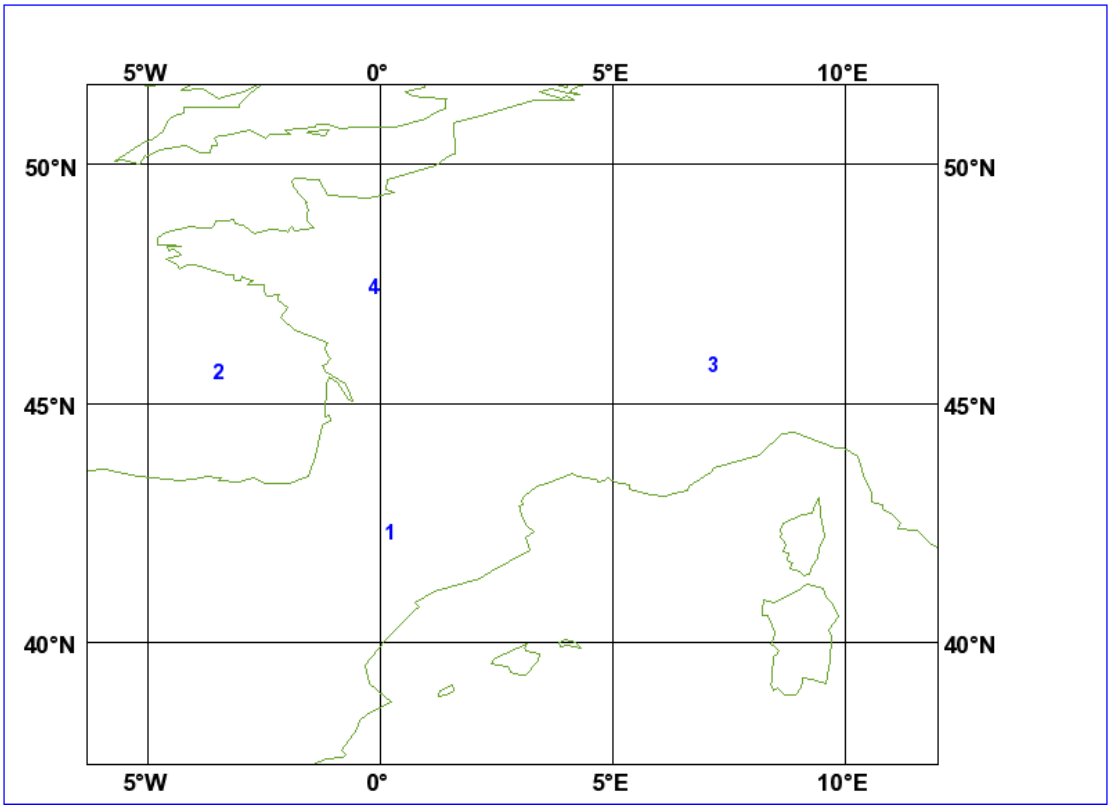

Figure 1. The domain used: 600x512 points, 2.5 km horizontal resolution and 41 vertical levels. 4 points are used by Echkevo for producing sequential output of time series.

Table 1. Coordinates of points used for Echkevo output.

Point No	LAT	LON
1	42.3292	0.2433
2	45.6889	356.5801
3	45.8297	7.2199
4	47.4913	359.8879

Table 2. Experiment names and descriptions

Experiment Name	Description
82FY	AROME with Dynamic Adaptation, DFI=off, LSPRT=TRUE and Echkevo output at levels 21, 31 and 41
82G4	AROME with AROME analysis, DFI=off, LSPRT=TRUE and Echkevo output at levels 21, 31 and 41
82G7	AROME with 6h previous AROME, DFI=off, LSPRT=TRUE and Echkevo output at levels 21, 31 and 41
82GA	Same as 82FY but 1 minute output
82GD	Same as 82G4 but 1 minute output
82GE	Same as 82G7 but 1 minute output

82GG	Same as 82FY but DFI=on (TAUS=121 and NSTDFI=4)
82GH	Same as 82FY but DFI=on (TAUS=240 and NSTDFI=4)
82GI	Same as 82FY but DFI=on (TAUS=360 and NSTDFI=4)
82GJ	Same as 82FY but DFI=on (TAUS=480 and NSTDFI=4)
82GK	Same as 82FY but DFI=on (TAUS=600 and NSTDFI=5)
82H0	Same as 82GG but 1 minute output
82H1	Same as 82FY and DFI=on (TAUS=10800 and NSTDFI=45)
82HD	Same as 82GD and DFI=on (TAUS=121 and NSTDFI=4)
82HN	Same as 82FY but Echkevo output at levels 39, 40 and 41
82HO	Same as 82GG but Echkevo output at levels 39, 40 and 41
82HV	Same as 82GG but LSPRT=FALSE

3) Results

All the experiments for 82FY, 82G4 and 82G7 were run for 6 hourly iteration. Initial condition for 82FY is from dynamic adaptation; initial condition for 82G4 is from AROME analysis and initial condition for 82G7 is from 6h previous AROME. In those experiments, Digital Filter (DFI) was set NEINI=0 in namelist “NAMINI” as default value which means that DFI is off. So it was expected to be seen same oscillation patterns shown by Jure Cedilnik on December 2007.

Figure 2 shows temperature evolution at the lowest model level (41) for 4 points for 150 minutes period although experiment 82FY was run for 360 minutes. Oscillations are seen at point 1, 3 and 4 but amplitude is bigger at point 3 which is located on the Alps. The difference between the first sequential time steps of simulation has an amplitude about 7-8 degrees and there is a relaxation afterwards. There is no oscillation after 90 minutes.

Figure 3 shows vorticity evolution and Figure 4 shows divergence evolution at the lowest model level (41) for 4 points for 150 seconds period. Oscillation patterns can be seen in Figure 3 and 4 for point 3.

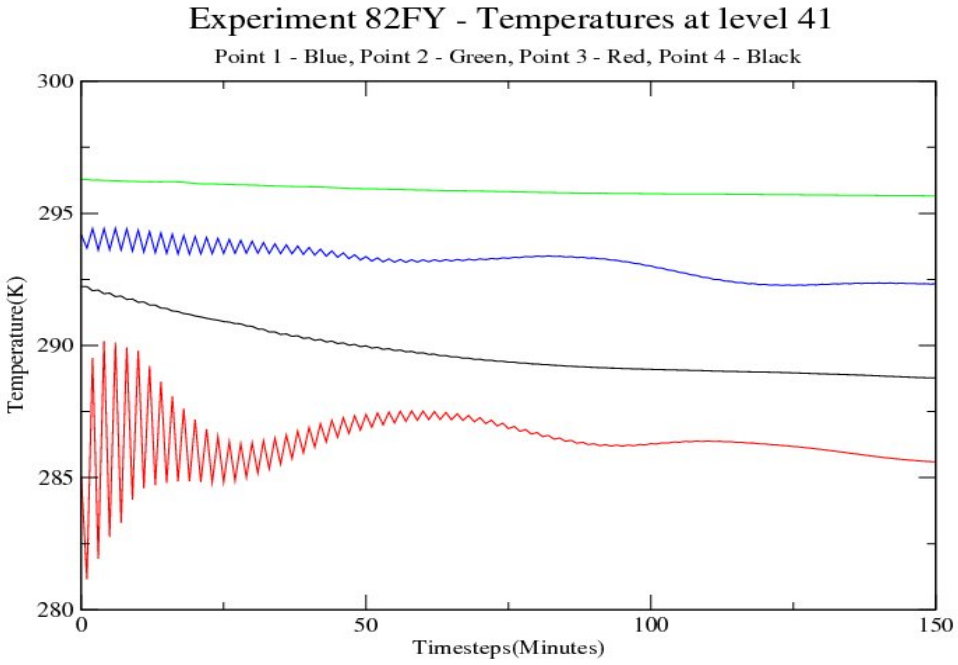

Figure 2. Time series of temperature at the lowest model level for experiment 82FY.

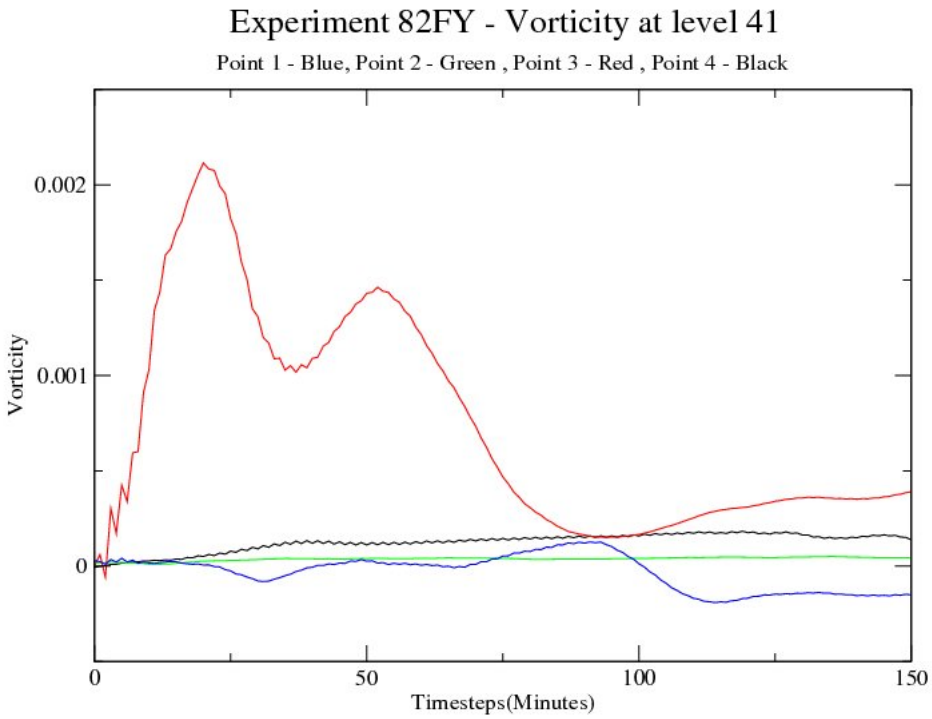

Figure 3. Time series of vorticity at the lowest model level for experiment 82FY.

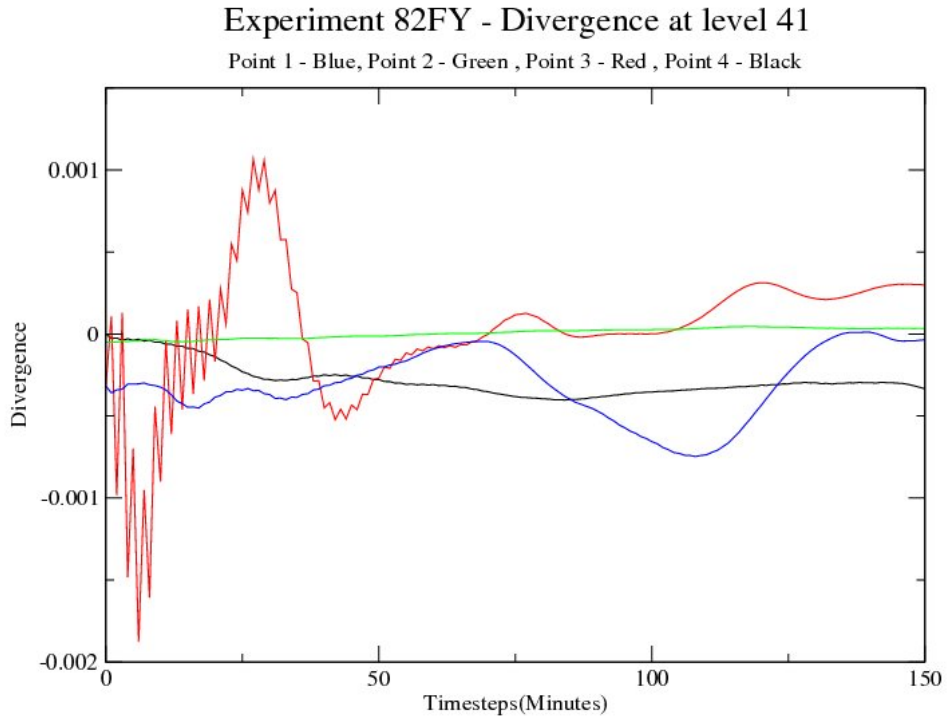

Figure 4. Time series of divergence at the lowest model level for experiment 82FY.

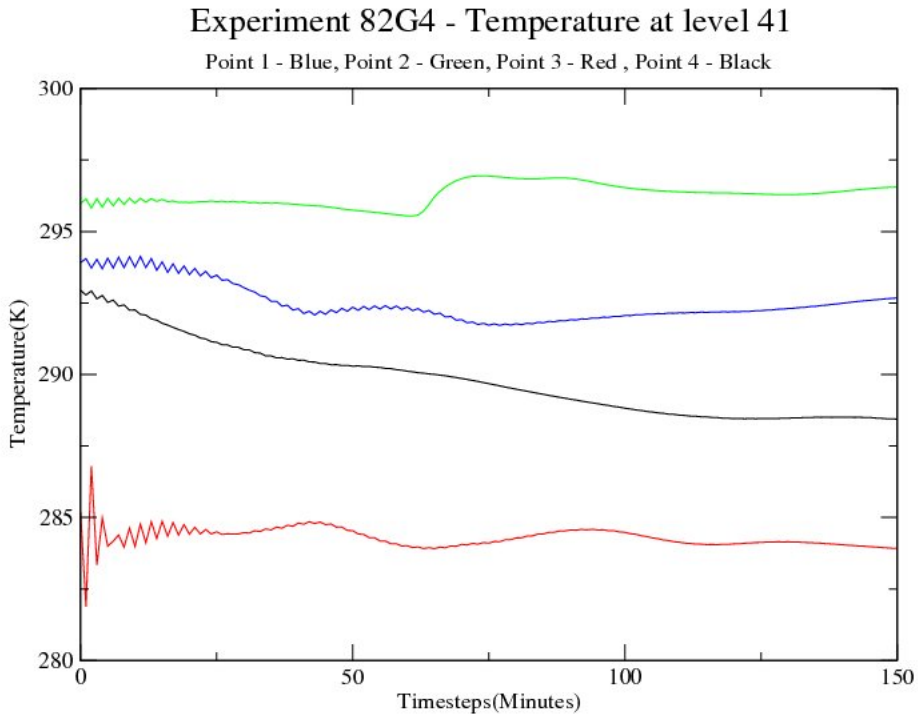

Figure 5. Time series of temperature at the lowest model level for experiment 82G4.

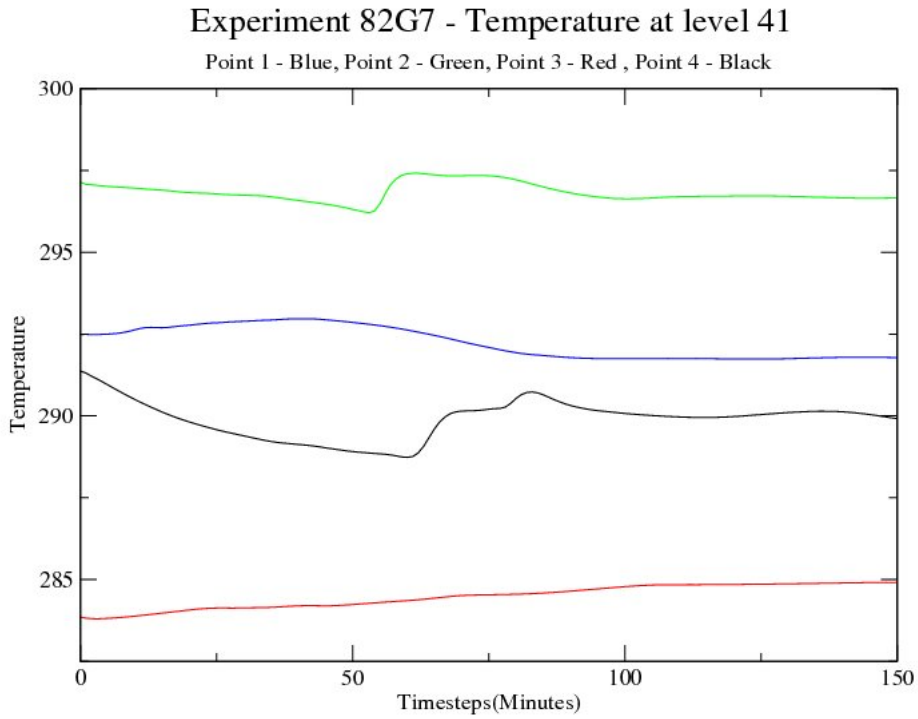

Figure 6. Time series of temperature at the lowest model level for experiment 82G7.

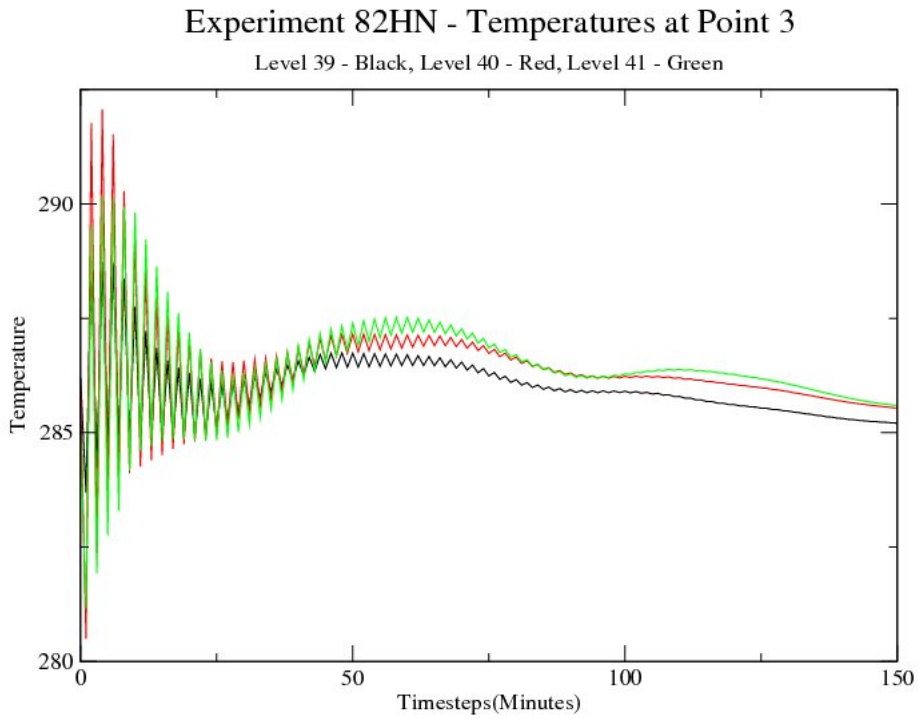

Figure 7. Time series of temperature at model levels 39, 40 and 41 for experiment 82HN at point 3.

Figure 5 shows results for experiment 82G4. There are still oscillations but the amplitudes are smaller than experiment 82FY.

Figure 6 shows experiment 82G7 results. There is no oscillation in the grid points. Oscillations are also seen at the levels 39 and 40 for temperature at point 3 (Figure 7). Those results for experiments 82FY, 82G4, 82G7 and 82HN were obtained without digital filter.

All the oscillation patterns without DFI resemble the result shown by Jure Cedilnik who has studied same topic on December 2007.

4) Digital Filter

Experiment 82FY was chosen to switch on DFI to see whether oscillations were still going on or not.

To switch on DFI, NEINI was set to 2 in the namelist NAMINI.

Cut off periods of DFI in the namelist NAMDFI were set to ;
82GG - 1 minute (TAUS=121 ve NSTDFI=4)
82GH - 2 minutes (TAUS=240 ve NSTDFI=4),
82GI - 3 minutes (TAUS=360 ve NSTDFI=4),
82GJ - 4 minutes (TAUS=480 ve NSTDFI=4),
82GK - 5 minutes (TAUS=600 ve NSTDFI=5)

Figure 8 shows the evolution of temperatures at the lowest model level (41) for point 3 for the experiments with the different DFI tunings. There are no temperature oscillations. Each experiment results are very close to each other but not same.

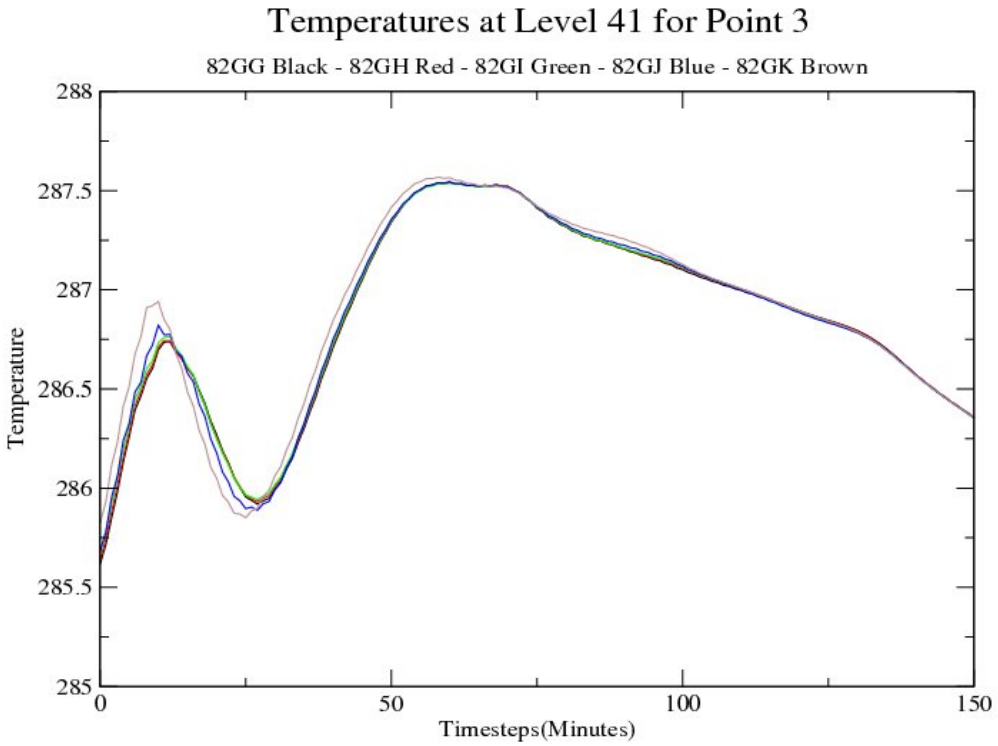

Figure 8. Time series of temperature at the lowest model level (41) for experiment 82GG, 82GH, 82GI, 82GJ and 82GK with different DFI settings.

Figure 9 shows experiments 82FY, 82H1, 82GG, 82GH, 82GI, 82GJ and 82GK. Experiment 82H1 has default DFI settings as TAUS=10800 and NSTDFI=45. In this case, temperature oscillation is still appearing but it has much lower amplitude than experiment 82FY. This result resembles the results shown by Jure Cedilnik.

Although oscillation is finished by DFI which has short cut off period, it is clearly seen that forecasts are different than one without DFI.

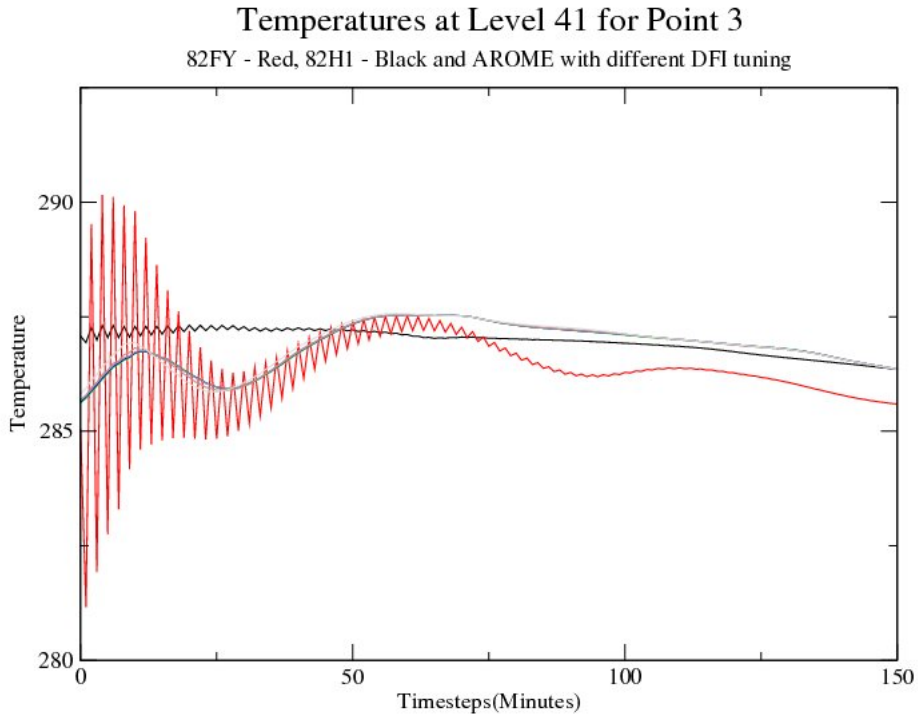

Figure 9. Time series of temperature at the lowest model level (41) for experiment 82GG, 82GH, 82GI, 82GJ and 82GK with different DFI settings; 82FY and 82H1.

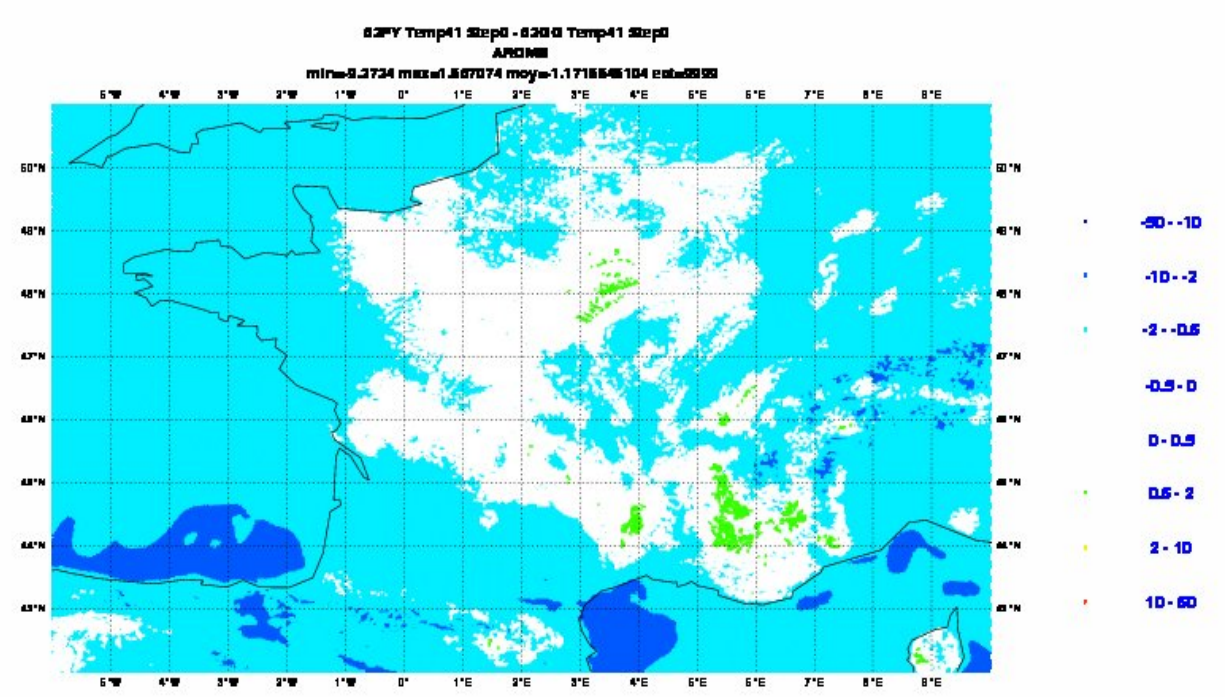

Figure 10. Model field difference for analysis step of temperature between 82FY and 82GG.

To determine where those differences take place, analysis step of experiment 82FY (without DFI) was subtracted from analysis step of 82GG (with DFI). The plots of model field differences were shown by Figure 10.

The model field difference has amplitude from -2 to -10 degrees over areas which are northern and eastern part of Pyrenees.

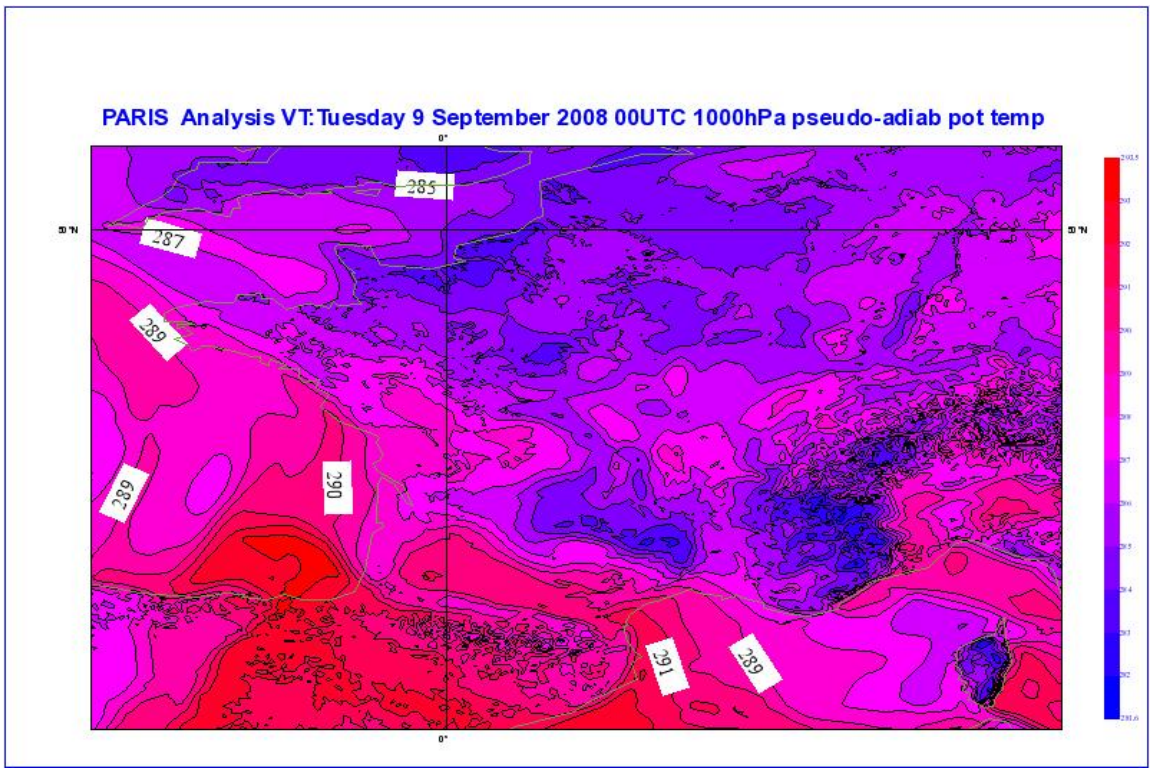

Figure 11. Pseudo-adiabatic potential temperature at 1000 hPa for analysis step of experiment 82FY.

Figure 11 shows pseudo-adiabatic potential temperature at 1000 hPa for analysis step of experiment 82FY. Higher temperature areas in the vicinity of Pyrenees are similar pattern as shown in Figure 12.

Figure 12 shows model field difference for analysis step of temperature between 82HV and 82GG. Both of the experiments 82HV and 82GG are with DFI. LSPRT tuning in 82GG is true but LSPRT tuning in 82HV is false.

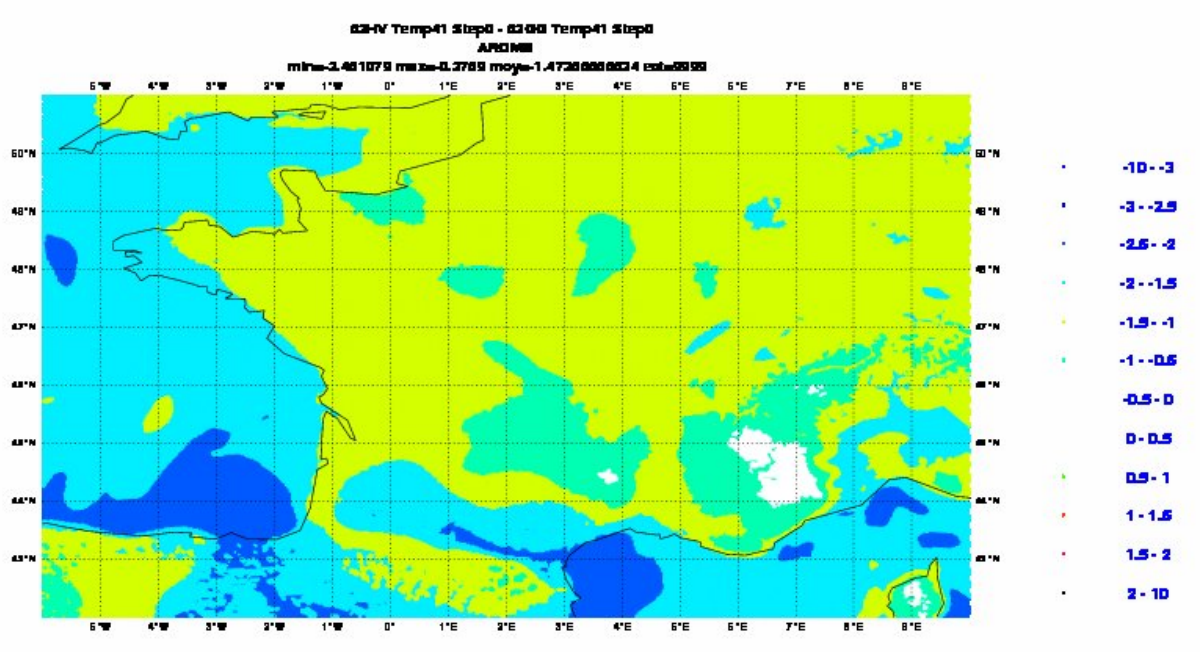

Figure 12. Model field difference for analysis of temperature between 82HV and 82GG.

Figure 13 shows model field difference for analysis step of temperature between 82FY and 82HV. Experiment 82FY is without DFI tuning but 82HV is with DFI. LSPRT tuning in 82FY is true but LSPRT tuning in 82HV is false. There are no differences bigger than 0.5 degrees over areas which are northern and eastern part of Pyrenees.

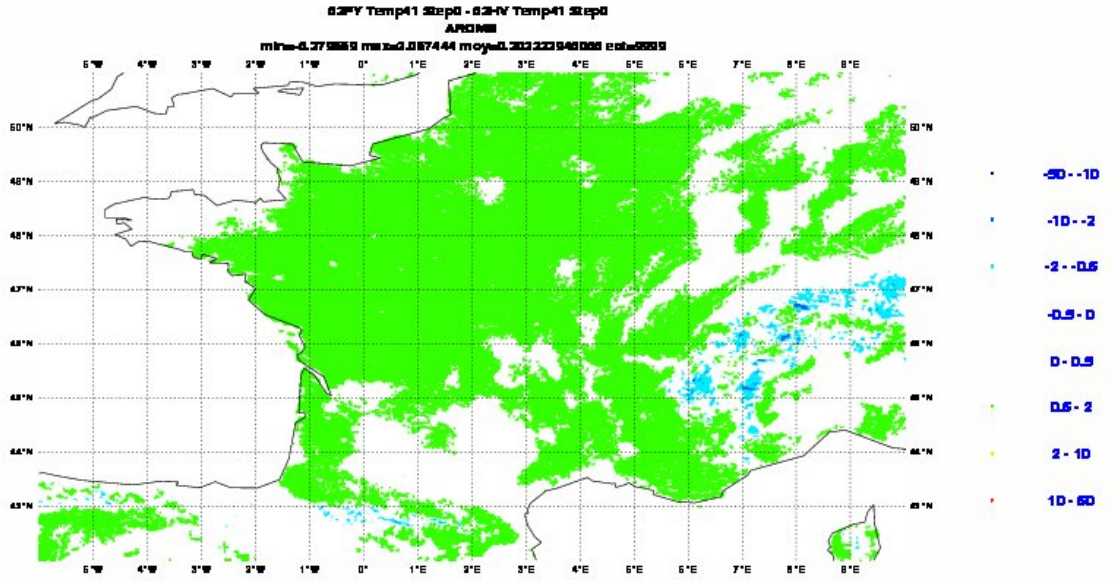

Figure 13. Model field difference for analysis of temperature between 82FY and 82HV.

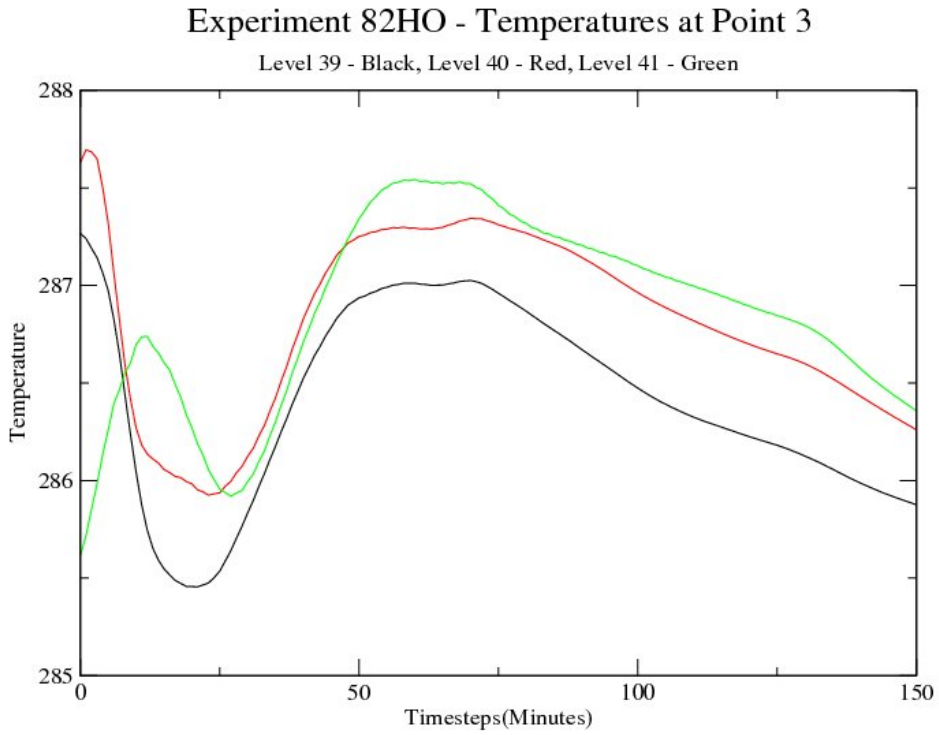

Figure 14. Time series of temperature at model levels 39, 40 and 41 for experiment 82HO at point 3.

Figure 14 shows the evolution of temperatures at model levels (39, 40 and 41) for point 3 for experiments 82HO. Although oscillations are seen at three levels in Figure 7, there are no oscillations using with short cut off period of DFI.

5) Technical documentation

Olive swapp environment was used for all the experiment. All experiment can be found in swapp environment under user mrpe713.

A tool for processing Echkevo files is on tori under /cnrm/gp/mrpe/mrpe713/SPINUP/PROGRAM/OUTECHKEVO.

All Echkevo plots, difference maps, scripts and programs can be found on tori: cnrm/gp/mrpe/mrpe713/SPINUP.

6) Literature

Fischer, Claude; 2007: Internal talk on assimilation meeting, Toulouse, October 2007; *cougar:* ~mrpe722/3DVAR/TESTCASES/3DVAR_IDFI.ppt

Cedilnik, Jure; 2007: Study of spinup properties in AROME RUC 3DVAR, Toulouse, December 2007; *sxalgo1:* /home/cedilnik/arome_spinup