PHASING REPORT

STUDIES ON THE LATEST DEVELOPMENTS IN ARPEGE/IFS

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FEBRUARY – MARCH 2013

This report of phasing summarizes my stay in Toulouse from February 4th to March 15th 2013 with the phasing team of GMAP.

During this stay, my main tasks were :
1/ Validation of new versions of al39_t1 (versions 02, 03 and 04).
2/ Fix of norm violations.
3/ Code cleaning.

I. Environment preparation :

In order to validate the versions of the al39_T1 cycle, I used to check some Mitraillette test results, but first of all, I should prepare the corresponding environment. In fact, user should create new folders:

${HOME}/SAVE/mitraille

The folder "mitraille" for cycle 39 should then contain the following folders and files:

- al39t1 : Folder that will contain output files of cycle al39_t1;
- mitra_home_location : File containing arborescence path;
- mitraillette.x : Executable file;
- namelist: Folder containing cycle namelists;
- PRO_FILE.al39 : File containing the list of tasks to launch;
- protojobs: Folder containing job files and time/memory settings.

Launching Mitraillette test:

After preparing all environment files, user can launch the Mitraillette test within the following command line:

mitraillette_executable_file Cycle_name_in_capital_letters PRO_FILE mono/multi

The user can choose between the mono-processor or the multi-processor run in the last command line parameter.
We can consider as an example the launch of AL39_T1.02 test in mono-processor run:

==> mitraillette.x AL39T1 PRO_FILE.cy39 mono

This command line will launch the run of the different tasks included in the PRO_FILE file. An example of PRO_FILE is following:

ah1e cy39_master-t1.02.SX20r441.x.exe ${HOME}/SAVE/executable/cy39_master-t1.02.SX20r441.x.exe
ah1s cy39_master-t1.02.SX20r441.x.exe ${HOME}/SAVE/executable/cy39_master-t1.02.SX20r441.x.exe
ah1t cy39_master-t1.02.SX20r441.x.exe ${HOME}/SAVE/executable/cy39_master-t1.02.SX20r441.x.exe

II. Validation of al39_T1 :

The validation test was applied upon the following list of tasks :

Table 1: List of mitraillette tasks run for validation

ah1e	ah1s	ah1t	ah5e	ah5t	ah4e	ah4t	ah6e
ah6t	ah8e	ah8t	an1e	an1s	an1t	ahut	arut
ah2s	ah2t	an2s	an2t	ah9e	ahfe	agit	ag1t
aa1t	ac1t	ac1u	ac5t	ac4t	ar1t	axcx	axsx

The above codes mean some mitraillette configurations tests as described by Vanda Sousa da Costa in “Procedure to validate a release of the code Aladin” document. The nomenclature of different jobs is in the form of a A[B][n][C] code. The following table explaines this nomenclature rule with more details:

Table 2: Nomenclature of configurations

A	Limited Area Model (use G for global model)
[B]	
H	for hydrostatic adiabatic
G	with physics in the non-linear trajectory
N	for non-hydrostatic adiabatic
M	with physics
Q	for hydrostatic with physics, var.Q in grid point
[n]	**Configuration**
1	for E001 configuration
2	for ALADIN 2D vertical plane model
4	for E401 configuration
5	E501
6	E601
8	E801
9	E927/EE927
F	Fullpos
I	Incremental DFI
C	E923 / Clim files preparation
[C]	**Advection scheme and coupling**
E	for eulerian advection
S	for 3 time level semi-lagrangian advection scheme
T	for 2 time level semi-lagrangian advection scheme
C	without coupling files
O	Old equivalent of AG1T
R	AROME (=> 2tl semi-lagrangian with PC)
X	not applicable to choosen configuration

The first run of these mitraillette tests was for reference, using the cy39_main.01 version. It was turned twice on both mono and multi processors runs. This reference will serve for comparison and validation of the al39_t1 versions.

1/ Validation of al39_t1.02 :

For the validation of al39_t1.02 version, I used to compare spectral norms digits, but for some configurations as for example E401 or E501, more validation tests were required. The comparison results are summarized in the following tables.:

AH1E : Hydrostatic adiabatic E001 with eulerian advection scheme	
AL39	AL39T1
NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.115099863749898E+02 OROGRAPHY 0.368206327860646E+04 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.363280232616224E-04 0.176359489166441E-04 0.253884982227815E+03 0.201257112561138E-02 0.436013620313526E+02 **NORMS AT NSTEP CNT4 30** SPECTRAL NORMS - LOG(PREHYDS) 0.115097756705575E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.363263679867358E-04 0.194339435731647E-04 0.253867304859382E+03 0.200468983659451E-02 0.433822810321120E+02	**NORMS AT NSTEP CNT4 0** SPECTRAL NORMS - LOG(PREHYDS) 0.115099863749898E+02 OROGRAPHY 0.368206327860646E+04 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.363280232616224E-04 0.176359489166441E-04 0.253884982227815E+03 0.201257112561138E-02 0.436013620313526E+02 **NORMS AT NSTEP CNT4 30** SPECTRAL NORMS - LOG(PREHYDS) 0.115097756705575E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.363263679867358E-04 0.194339435731647E-04 0.253867304859382E+03 0.200468983659451E-02 0.433822810321120E+02

For the validation of the E501 configuration, we considered the test of the tangent linear model. It consists on the test of the order 1 of the Taylor expansion of the non-linear model.

AH5E : Hydrostatic adiabatic E501 (Eulerian adv. scheme)	
AL39	AL39T1
TEST OF THE TANGENT LINEAR LAMBDA = 0 PRES. I = 1 RAT = 0.1041431920290715E+01 -.29455E-05 0.11510E+02 0.11510E+02 0.11510E+02 -.28283E-05 -.11301E-04 0.11510E+02 VORT. I = 3817 RAT = 0.1006554450976052E+01 0.37463E-06 0.92541E-06 0.59411E-06 0.12186E-05 0.37219E-06 0.62450E-06 0.55078E-06 VORT. I = 7633 RAT = 0.9956842493114675E+00 0.73010E-07 -.12847E-06 -.23031E-06 0.53425E-07 0.73326E-07 0.28374E-06 -.20148E-06	TEST OF THE TANGENT LINEAR LAMBDA = 0 PRES. I = 1 RAT = 0.1041431920290715E+01 -.29455E-05 0.11510E+02 0.11510E+02 0.11510E+02 -.28283E-05 -.11301E-04 0.11510E+02 VORT. I = 3817 RAT = 0.1006554450976052E+01 0.37463E-06 0.92541E-06 0.59411E-06 0.12186E-05 0.37219E-06 0.62450E-06 0.55078E-06 VORT. I = 7633 RAT = 0.9956842493114675E+00 0.73010E-07 -.12847E-06 -.23031E-06 0.53425E-07 0.73326E-07 0.28374E-06 -.20148E-06

The validation of the E401 configuration is based on the test of the adjoint model. The number of equal digits depends on how much physics are switched on in the model. In case of adiabatic eulerian model, 12 or 13 equal digits should be obtained.

AH4E : Hydrostatic adiabatic E401	
AL39	AL39T1
TEST OF THE ADJOINT 1,23E+19 < F(X) , Y > = 0.45181675019687946720E-02 < X , F*(Y) > = 0.45181675019687929400E-02 THE DIFFERENCE IS 1.729 TIMES THE ZERO OF THE MACHINE	TEST OF THE ADJOINT 1,23E+19 < F(X) , Y > = 0.45181675019687946720E-02 < X , F*(Y) > = 0.45181675019687929400E-02 THE DIFFERENCE IS 1.729 TIMES THE ZERO OF THE MACHINE

The validation of the E801 configuration is based on the test of gradient. The cost function is calculated as the distance between the model forecast and the reference analysis.

AH8E : Hydrostatic adiabatic E801	
AL39	AL39T1
GRTEST gradient T1= 0.9948408407274573 GRTEST gradient T1= 0.9990354686741160 GRTEST gradient T1= 0.9999309810771044 GRTEST gradient T1= 0.9999930049187090 GRTEST gradient T1= 0.9999986769644720 GRTEST gradient T1= 0.9999971335232737 GRTEST gradient T1= 0.9999719306626423 GRTEST gradient T1= 0.9997193362269819 GRTEST gradient T1= 0.9971933786867416 GRTEST gradient T1= 0.9719337841836601 GRTEST gradient T1= 0.7193376541322009 GRTEST gradient T1= -1.806498386513473	GRTEST gradient T1= 0.9948408407274573 GRTEST gradient T1= 0.9990354686741160 GRTEST gradient T1= 0.9999309810771044 GRTEST gradient T1= 0.9999930049187090 GRTEST gradient T1= 0.9999986769644720 GRTEST gradient T1= 0.9999971335232737 GRTEST gradient T1= 0.9999719306626423 GRTEST gradient T1= 0.9997193362269819 GRTEST gradient T1= 0.9971933786867416 GRTEST gradient T1= 0.9719337841836601 GRTEST gradient T1= 0.7193376541322009 GRTEST gradient T1= -1.806498386513473

The validation of the E601 configuration is based on the calculation of the singular values and singular vectors of the tangent and adjoint models which are listed below the RITZ character sequence.

AH6E : Hydrostatic E601 with simplified Buizza physics	
AL39	AL39T1
TQLB exited with IERR = 0 TQLB delivered... J = 1 FIRST = 2 LAST = 1 ID1 = 1 L = 1 I = 1 |BND|^2 = 1.00000000000000D+00 I RITZ(I) (BND(I)) ALF(I) BET(I) 1 1.17515361694795D+00 (1.00000000000000D+00) 1.175D+00 2.356D-09 DSORT2 delivered... 1 1.17515361694795D+00 (4.20598182669482D-01) J ** RITZ ** EIG=SQRT(ABS(RITZ)) ** BND 1 0.117515361695E+01 0.108404502533E+01 0.420598182669E+00 ** OK ** 0.3579E-03	TQLB exited with IERR = 0 TQLB delivered... J = 1 FIRST = 2 LAST = 1 ID1 = 1 L = 1 I = 1 |BND|^2 = 1.00000000000000D+00 I RITZ(I) (BND(I)) ALF(I) BET(I) 1 1.17515361694795D+00 (1.00000000000000D+00) 1.175D+00 2.356D-09 DSORT2 delivered... 1 1.17515361694795D+00 (4.20598182669482D-01) J ** RITZ ** EIG=SQRT(ABS(RITZ)) ** BND 1 0.117515361695E+01 0.108404502533E+01 0.420598182669E+00 ** OK ** 0.3579E-03

AG1T : Hydrostatic oper-type E001 (3 hour+2TLSL+oper physics) with echkevo and B-level	
AL39	AL39T1
NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.115093445868813E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.475829399503399E-04 0.349315308795090E-04 0.246833638991243E+03 0.151890006807550E-02 0.138097132164668E+03 NORMS AT NSTEP CNT4 96 SPECTRAL NORMS - LOG(PREHYDS) 0.115091777396932E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.485070678555386E-04 0.387482724560135E-04 0.246871548789360E+03 0.148096462412259E-02 0.158217003345556E+03	NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.115093444147061E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.475917478354349E-04 0.349260349010091E-04 0.246833537448083E+03 0.151898285818887E-02 0.138106054823251E+03 NORMS AT NSTEP CNT4 96 SPECTRAL NORMS - LOG(PREHYDS) 0.115091747559684E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.486292931917657E-04 0.387618160809375E-04 0.246873418857434E+03 0.148199860186444E-02 0.158234772344741E+03

AA1T : Conf 001 LACE-ALARO	
AL39	AL39T1
NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.114939054727716E+02 OROGRAPHY 0.300349554410728E+04 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.705854830365691E-04 0.499197637338880E-04 0.244650295839856E+03 0.131627372888052E-02 0.285197626166177E+03 NORMS AT NSTEP CNT4 120 SPECTRAL NORMS - LOG(PREHYDS) 0.114976700739546E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.697032489372186E-04 0.549670981637591E-04 0.244410943640306E+03 0.124618802228202E-02 0.264477494227121E+03	NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.114939063184450E+02 OROGRAPHY 0.300349554410728E+04 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.705861590363605E-04 0.499207644930925E-04 0.244650185835719E+03 0.131648621605339E-02 0.285197567327398E+03 NORMS AT NSTEP CNT4 120 SPECTRAL NORMS - LOG(PREHYDS) 0.114976702353364E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.697382741480206E-04 0.549996359928514E-04 0.244410906797632E+03 0.124605874721983E-02 0.264480263413646E+03

AR1T : Conf 001 AROME	
AL39	AL39T1
NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.114848609196616E+02 OROGRAPHY 0.399316573203574E+04 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.852556942475648E-04 0.809947694606324E-04 0.256351366366780E+03 0.288086256138754E+03 NORMS AT NSTEP CNT4 1 SPECTRAL NORMS - LOG(PREHYDS) 0.114848580366639E+02 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.856943357945765E-04 0.990723842610016E-04 0.256345417901333E+03 0.288195770651638E+03 NORMS AT NSTEP CNT4 240 SPECTRAL NORMS - LOG(PREHYDS) 0.114839818080650E+02 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.156994984941599E-03 0.145978793862156E-03 0.255438468970612E+03 0.272596396660767E+03	NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.114848609196616E+02 OROGRAPHY 0.399316573203574E+04 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.852556942475648E-04 0.809947694606324E-04 0.256351366366780E+03 0.288086256138754E+03 NORMS AT NSTEP CNT4 1 SPECTRAL NORMS - LOG(PREHYDS) 0.114848580366772E+02 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.856599232293543E-04 0.990629271117537E-04 0.256345414092091E+03 0.288197540732631E+03 NORMS AT NSTEP CNT4 240 SPECTRAL NORMS - LOG(PREHYDS) 0.114839818173719E+02 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.156919444708413E-03 0.145928179881995E-03 0.255437478810209E+03 0.272639559779926E+03

During this verification, we could detect few errors in some configurations, these errors were mainly about:

- Segmentation violation in configuration AH8T during the multi processing run;
- WIND TOO STRONG, EXPLOSION!! in configuration AC5T;
- Cpu time limit error detected in configuration AC5T.

Other errors could be detected in the mitraillette test, but were fixed later by Philippe. The fix pack was then introduced in the version 03 of cy39_T1. These errors are about :

- Segmentation violation in configurations AHUT and ARUT;
- Bus errors related to fa_mod file in configurations AN1E and AN1S;
- Bus errors related to grip_api file in configurations AHFE;
- Bus errors in configuration AH9E, AR1T and AXCX.

Graphical comparison of results:

ALADIN :

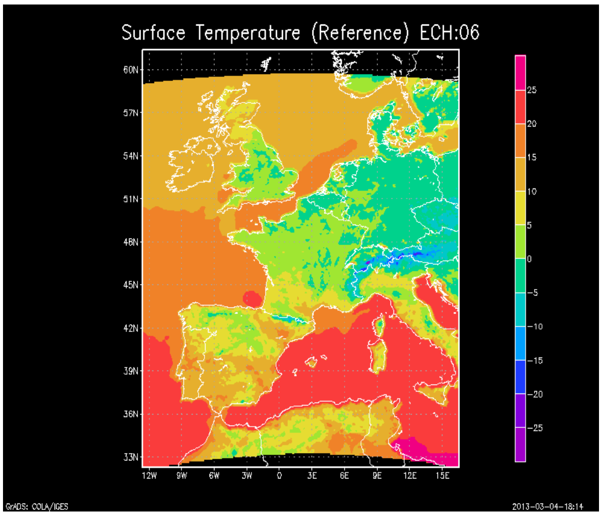

Figure 1: Surface Temperature with al39_main.01 ECH:06

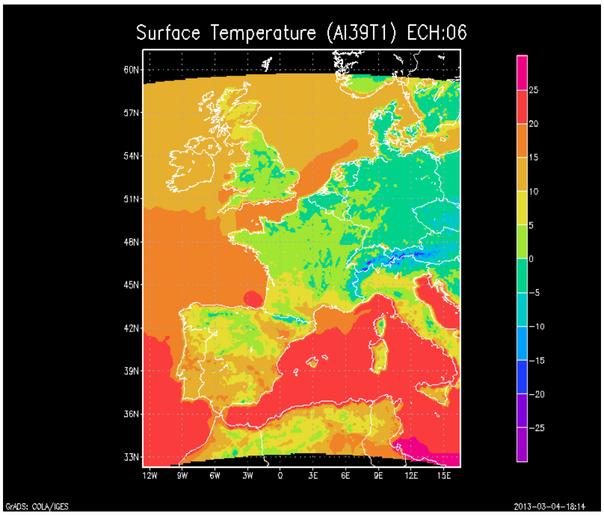

Figure 2: Surface Temperature with al39_T1.02 ECH:06

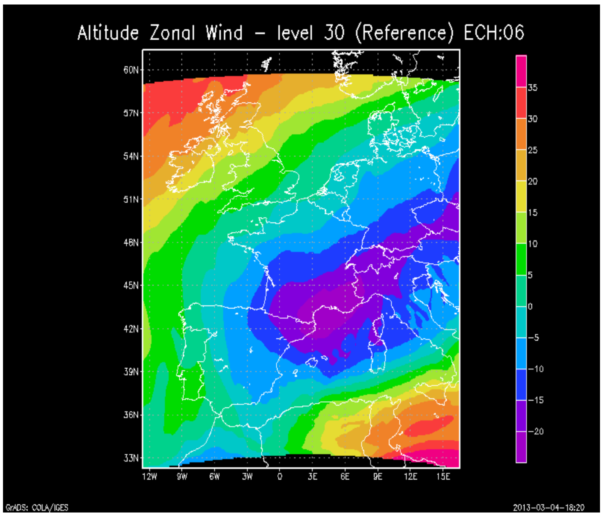

Figure 3: Zonal Altitude Wind with al39_main.01 (level 30) ECH:06

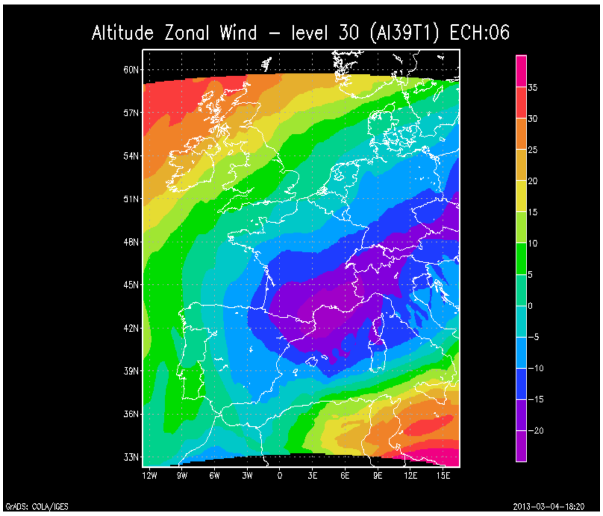

Figure 4: Zonal Altitude Wind with al39_T1.02 (level 30) ECH:06

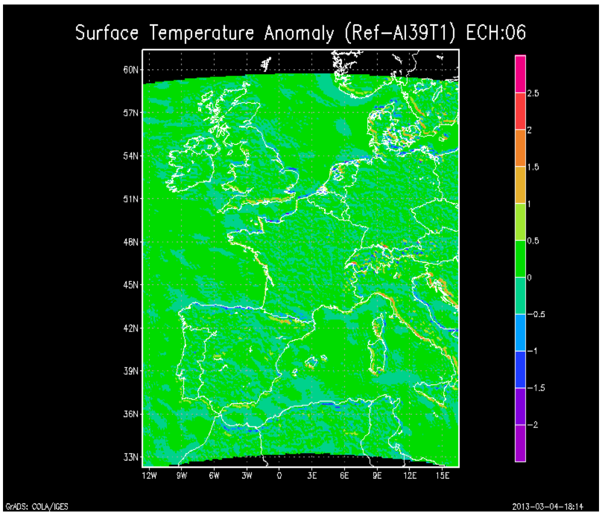

Figure 5: Surface Temperature Anomaly (Ref – al39_T1.02)

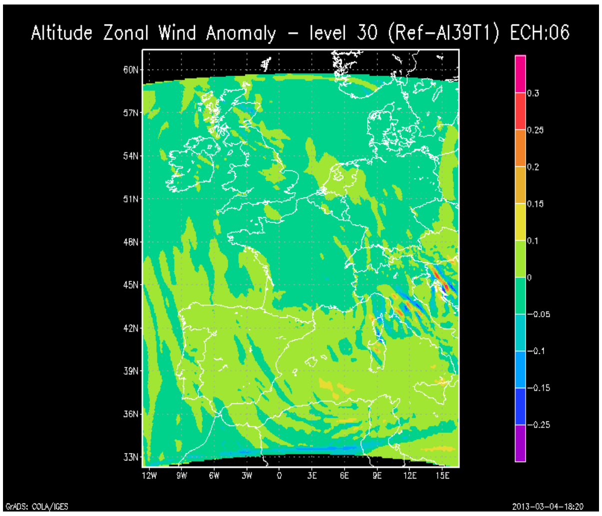

Figure 6: Zonal Altitude Wind Anomaly – level 30 (Ref – al39_T1.02)

AROME :

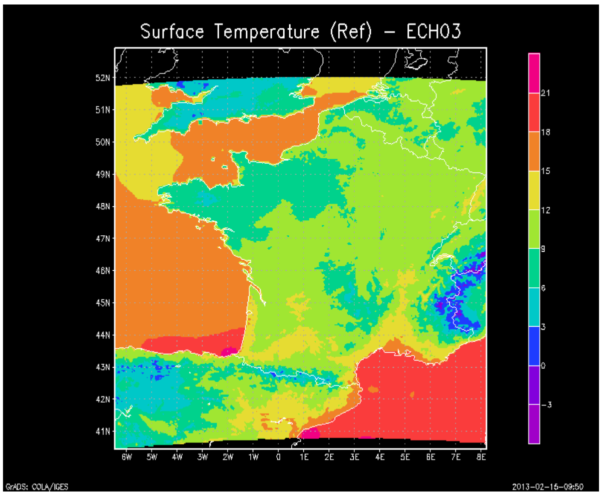

Figure 7: Surface Temperature with al39_main.01 ECH:03

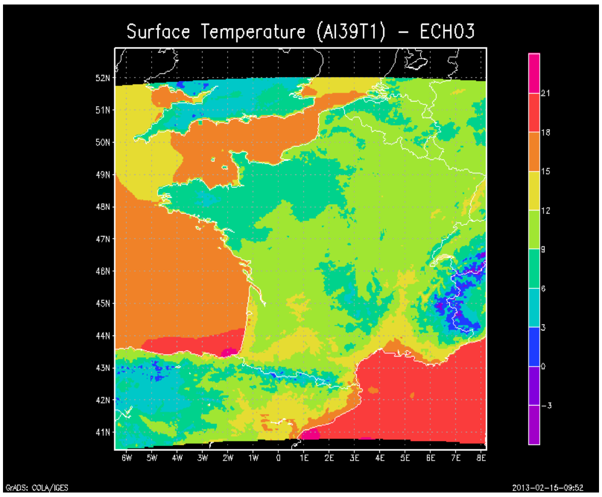

Figure 8: Surface Temperature with al39_T1.02 ECH:03

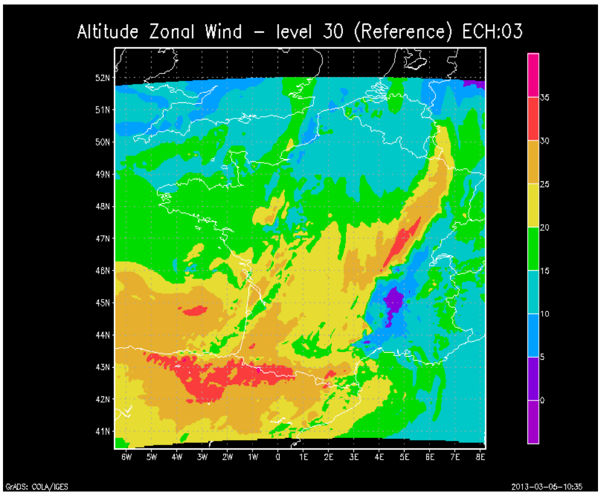

Figure 9: Zonal Altitude Wind with al39_main.01 (level 30) ECH:03

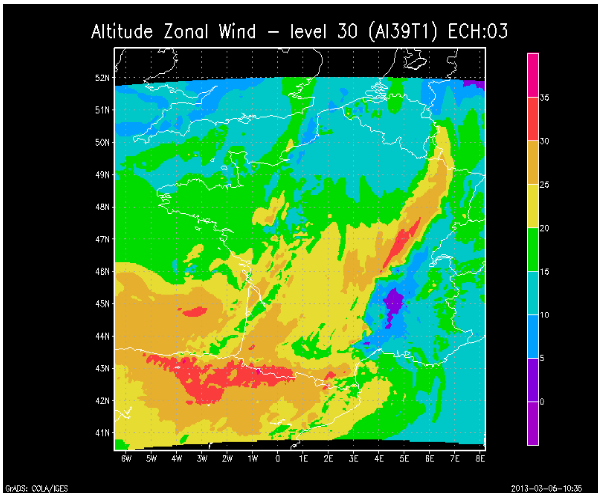

Figure 10: Zonal Altitude Wind with al39_T1.02 (level 30) ECH:03

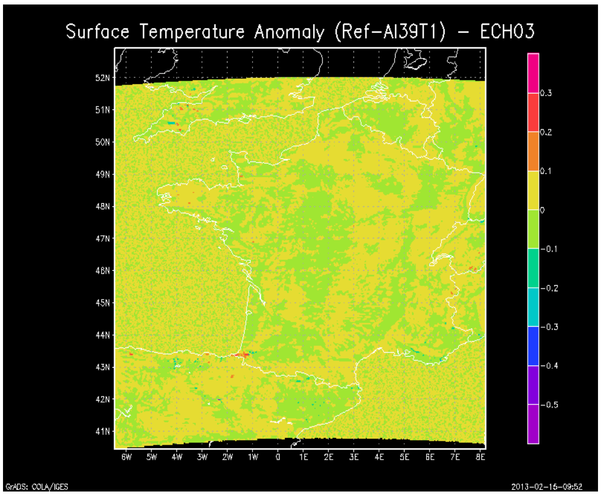

Figure 11: Surface Temperature Anomaly (Ref – al39_T1.02)

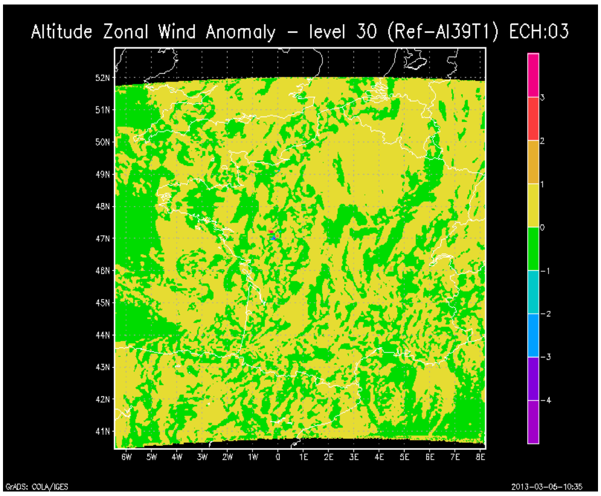

Figure 12: Zonal Altitude Wind Anomaly – level 30 (Ref – al39_T1.02)

ALARO :

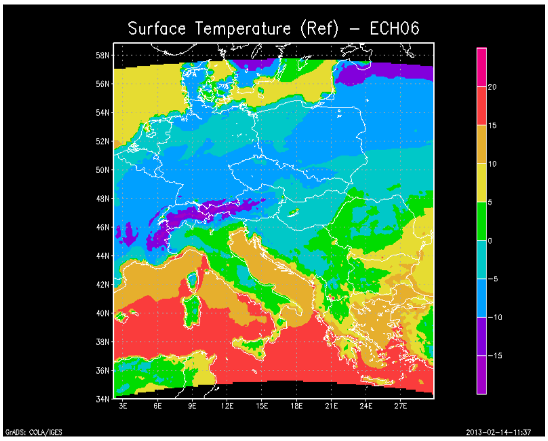

Figure 13: Surface Temperature with al39_main.01 ECH:06

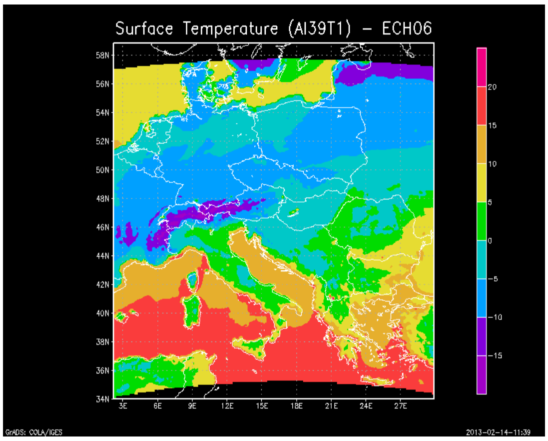

Figure 14: Surface Temperature with al39_T1.02 ECH:06

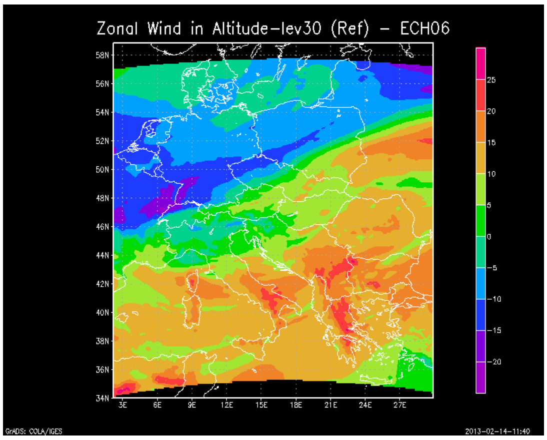

Figure 15: Zonal Altitude Wind with al39_main.01 (level 30) ECH:06

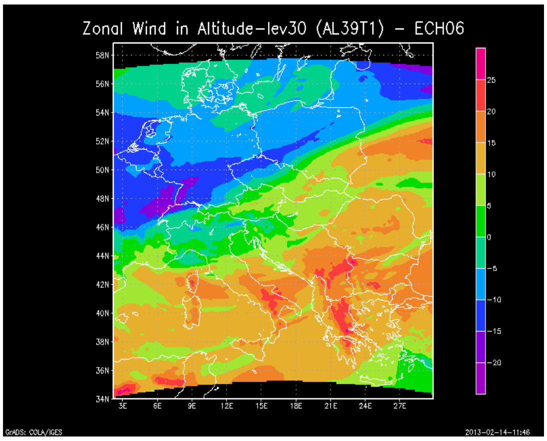

Figure 16: Zonal Altitude Wind with al39_T1.02 (level 30) ECH:06

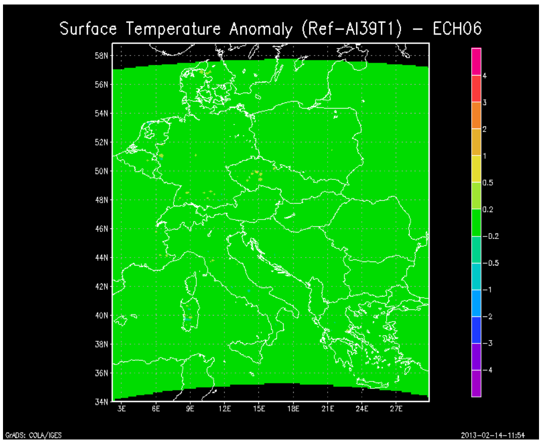

Figure 17: Surface Temperature Anomaly (Ref – al39_T1.02)

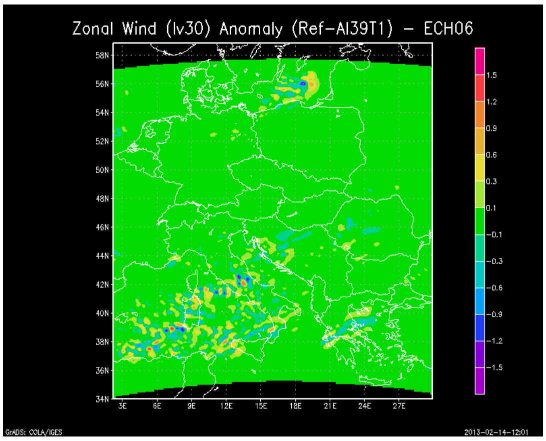

Figure 18: Zonal Altitude Wind Anomaly – level 30 (Ref – al39_T1.02)

2/ Validation of al39_T1.03 :

As for the validation of the second version, mitraillette tests were accomplished using the new al39_T1.03 binary. The following part is a summary of the main numerical results :

Mitraillette test numerical results:

The validation test was applied upon the following list of tasks :

ah1e	ah1s	ah1t	ah5e	ah5t	ah4e	ah4t	ah6e
ah6t	ah8e	ah8t	an1e	an1s	an1t	ahut	arut
ah2s	ah2t	an2s	an2t	ah9e	ahfe	agit	ag1t
aa1t	ac1t	ac1u	ac5t	ac4t	ar1t	axcx	axsx

AH1E : Hydrostatic adiabatic E001 with eulerian advection scheme	
AL39	AL39T1
NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.115099863749898E+02 OROGRAPHY 0.368206327860646E+04 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.363280232616224E-04 0.176359489166441E-04 0.253884982227815E+03 0.201257112561138E-02 0.436013620313526E+02 NORMS AT NSTEP CNT4 30 SPECTRAL NORMS - LOG(PREHYDS) 0.115097756705575E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.363263679867358E-04 0.194339435731647E-04 0.253867304859382E+03 0.200468983659451E-02 0.433822810321120E+02	NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.115099863749898E+02 OROGRAPHY 0.368206327860646E+04 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.363280232616224E-04 0.176359489166441E-04 0.253884982227815E+03 0.201257112561138E-02 0.436013620313526E+02 NORMS AT NSTEP CNT4 30 SPECTRAL NORMS - LOG(PREHYDS) 0.115097756705575E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.363263679867358E-04 0.194339435731647E-04 0.253867304859382E+03 0.200468983659451E-02 0.433822810321120E+02

AH5E : Hydrostatic adiabatic E501 (Eulerian adv. scheme)	
AL39	AL39T1
TEST OF THE TANGENT LINEAR LAMBDA = -8 PRES. I = 1 RAT = 0.1004908891024094E+01 -.28422E-13 0.11510E+02 0.11510E+02 0.11510E+02 -.28283E-05 -.11301E-04 0.11510E+02 VORT. I = 3817 RAT = 0.1000003672289241E+01 0.37219E-14 0.55078E-06 0.59411E-06 0.59411E-06 0.37219E-06 0.62450E-06 0.55078E-06 VORT. I = 7633 RAT = 0.9999506212685806E+00 0.73323E-15 -.20148E-06 -.23031E-06 -.23031E-06 0.73326E-07 0.28374E-06 -.20148E-06	TEST OF THE TANGENT LINEAR LAMBDA = -8 PRES. I = 1 RAT = 0.1004908891024094E+01 -.28422E-13 0.11510E+02 0.11510E+02 0.11510E+02 -.28283E-05 -.11301E-04 0.11510E+02 VORT. I = 3817 RAT = 0.1000003672289241E+01 0.37219E-14 0.55078E-06 0.59411E-06 0.59411E-06 0.37219E-06 0.62450E-06 0.55078E-06 VORT. I = 7633 RAT = 0.9999506212685806E+00 0.73323E-15 -.20148E-06 -.23031E-06 -.23031E-06 0.73326E-07 0.28374E-06 -.20148E-06

AH4E : Hydrostatic adiabatic E401	
AL39	AL39T1
TEST OF THE ADJOINT 1,234568E+19 < F(X) , Y > = 0.45181675019687946720E-02 < X , F*(Y) > = 0.45181675019687929400E-02 THE DIFFERENCE IS 1.729 TIMES THE ZERO OF THE MACHINE	TEST OF THE ADJOINT 1,234568E+19 < F(X) , Y > = 0.45181675019687946720E-02 < X , F*(Y) > = 0.45181675019687929400E-02 THE DIFFERENCE IS 1.729 TIMES THE ZERO OF THE MACHINE

AH8E : Hydrostatic adiabatic E801	
AL39	AL39T1
GRTEST gradient T1= 0.9948408407274573 GRTEST gradient T1= 0.9990354686741160 GRTEST gradient T1= 0.9999309810771044 GRTEST gradient T1= 0.9999930049187090 GRTEST gradient T1= 0.9999986769644720 GRTEST gradient T1= 0.9999971335232737 GRTEST gradient T1= 0.9999719306626423 GRTEST gradient T1= 0.9997193362269819 GRTEST gradient T1= 0.9971933786867416 GRTEST gradient T1= 0.9719337841836601 GRTEST gradient T1= 0.7193376541322009 GRTEST gradient T1= -1.806498386513473	GRTEST gradient T1= 0.9948408407274573 GRTEST gradient T1= 0.9990354686741160 GRTEST gradient T1= 0.9999309810771044 GRTEST gradient T1= 0.9999930049187090 GRTEST gradient T1= 0.9999986769644720 GRTEST gradient T1= 0.9999971335232737 GRTEST gradient T1= 0.9999719306626423 GRTEST gradient T1= 0.9997193362269819 GRTEST gradient T1= 0.9971933786867416 GRTEST gradient T1= 0.9719337841836601 GRTEST gradient T1= 0.7193376541322009 GRTEST gradient T1= -1.806498386513473

AH6E : Hydrostatic E601 with simplified Buizza physics	
AL39	AL39T1
TQLB exited with IERR = 0 TQLB delivered...J = 1 FIRST = 2 LAST = 1 ID1 = 1 L = 1 I = 1 |BND|^2 = 1.00000000000000D+00 I RITZ(I) (BND(I)) ALF(I) BET(I) 1 1.17515361694795D+00 (1.00000000000000D+00) 1.175D+00 2.356D-09 DSORT2 delivered... 1 1.17515361694795D+00 (4.20598182669482D-01) J ** RITZ ** EIG=SQRT(ABS(RITZ)) ** BND 1 0.117515361695E+01 0.108404502533E+01 0.420598182669E+00 ** OK ** 0.3579E-03	TQLB exited with IERR = 0 TQLB delivered... J = 1 FIRST = 2 LAST = 1 ID1 = 1 L = 1 I = 1 |BND|^2 = 1.00000000000000D+00 I RITZ(I) (BND(I)) ALF(I) BET(I) 1 1.17515361694795D+00 (1.00000000000000D+00) 1.175D+00 2.356D-09 DSORT2 delivered... 1 1.17515361694795D+00 (4.20598182669482D-01) J ** RITZ ** EIG=SQRT(ABS(RITZ)) ** BND 1 0.117515361695E+01 0.108404502533E+01 0.420598182669E+00 ** OK ** 0.3579E-03

AG1T : Hydrostatic oper-type E001 (3 hour+2TLSL+oper physics) with echkevo and B-level	
AL39	AL39T1
NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.115093445868813E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.475829399503399E-04 0.349315308795090E-04 0.246833638991243E+03 0.151890006807550E-02 0.138097132164668E+03 NORMS AT NSTEP CNT4 96 SPECTRAL NORMS - LOG(PREHYDS) 0.115091777396932E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.485070678555386E-04 0.387482724560135E-04 0.246871548789360E+03 0.148096462412259E-02 0.158217003345556E+03	NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.115093444147061E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.475917478354349E-04 0.349260349010091E-04 0.246833537448083E+03 0.151898285818887E-02 0.138106054823251E+03 NORMS AT NSTEP CNT4 96 SPECTRAL NORMS - LOG(PREHYDS) 0.115091747559684E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.486292931917657E-04 0.387618160809375E-04 0.246873418857434E+03 0.148199860186444E-02 0.158234772344741E+03

AA1T : Conf 001 LACE-ALARO	
AL39	AL39T1
NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.114939054727716E+02 OROGRAPHY 0.300349554410728E+04 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.705854830365691E-04 0.499197637338880E-04 0.244650295839856E+03 0.131627372888052E-02 0.285197626166177E+03 NORMS AT NSTEP CNT4 115 SPECTRAL NORMS - LOG(PREHYDS) 0.114976136788565E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.699712809584656E-04 0.551430217253107E-04 0.244395757117688E+03 0.124577938025938E-02 0.264270615052975E+03 NORMS AT NSTEP CNT4 120 SPECTRAL NORMS - LOG(PREHYDS) 0.114976700739546E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.697032489372186E-04 0.549670981637591E-04 0.244410943640306E+03 0.124618802228202E-02 0.264477494227121E+03	NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.114939063184450E+02 OROGRAPHY 0.300349554410728E+04 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.705861590363605E-04 0.499207644930925E-04 0.244650185835719E+03 0.131648621605339E-02 0.285197567327398E+03 NORMS AT NSTEP CNT4 115 SPECTRAL NORMS - LOG(PREHYDS) 0.114976138624140E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.700135823876371E-04 0.551772226738393E-04 0.244395750290226E+03 0.124564824864754E-02 0.264274160830927E+03 NORMS AT NSTEP CNT4 120 SPECTRAL NORMS - LOG(PREHYDS) 0.114976702353364E+02 LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY AVE 0.697382741480206E-04 0.549996359928514E-04 0.244410906797632E+03 0.124605874721983E-02 0.264480263413646E+03

AR1T : Conf 001 AROME	
AL39	AL39T1
NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.114848609196616E+02 OROGRAPHY 0.399316573203574E+04 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.852556942475648E-04 0.809947694606324E-04 0.256351366366780E+03 0.288086256138754E+03 NORMS AT NSTEP CNT4 1 SPECTRAL NORMS - LOG(PREHYDS) 0.114848580366639E+02 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.856943357945765E-04 0.990723842610016E-04 0.256345417901333E+03 0.288195770651638E+03 NORMS AT NSTEP CNT4 240 SPECTRAL NORMS - LOG(PREHYDS) 0.114839818080650E+02 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.156994984941599E-03 0.145978793862156E-03 0.255438468970612E+03 0.272596396660767E+03	NORMS AT NSTEP CNT4 0 SPECTRAL NORMS - LOG(PREHYDS) 0.114848609196616E+02 OROGRAPHY 0.399316573203574E+04 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.852556942475648E-04 0.809947694606324E-04 0.256351366366780E+03 0.288086256138754E+03 NORMS AT NSTEP CNT4 1 SPECTRAL NORMS - LOG(PREHYDS) 0.114848580366772E+02 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.856599232293543E-04 0.990629271117537E-04 0.256345414092091E+03 0.288197540732631E+03 NORMS AT NSTEP CNT4 240 SPECTRAL NORMS - LOG(PREHYDS) 0.114839818173719E+02 LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY AVE 0.156919444708413E-03 0.145928179881995E-03 0.255437478810209E+03 0.272639559779926E+03

- **Fix for ALARO:**

The Mitraillette tests for the validation of cy39_t1.02 and cy39_t1.03 revealed a non reproducibility of spectral norms between mono and multi-processors jobs for the ALARO configuration (AA1T) as shown in the following table (Comparison based on the Cy39_t1.03 version):

AA1T - MONO	AA1T - MULTI
NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114939063184450E+02 OROGRAPHY 0.300349554410728E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.114939063184450E+02 OROGRAPHY 0.300349554410728E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.705861590363605E-04 0.499207644930925E-04 0.244650185835719E+03 0.131648621605339E-02 0.285197567327398E+03	AVE 0.705861590363605E-04 0.499207644930925E-04 0.244650185835719E+03 0.131648621605339E-02 0.285197567327398E+03
NORMS AT NSTEP CNT4 5	NORMS AT NSTEP CNT4 5
SPECTRAL NORMS - LOG(PREHYDS) 0.114939227365194E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114939227365282E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.714941883191409E-04 0.513813754180353E-04 0.244610416819292E+03 0.131394427298258E-02 0.284067315819988E+03	AVE 0.714942000220337E-04 0.513813995528855E-04 0.244610416845699E+03 0.131394426301455E-02 0.284067312347454E+03
NORMS AT NSTEP CNT4 115	NORMS AT NSTEP CNT4 115
SPECTRAL NORMS - LOG(PREHYDS) 0.114976138624140E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114976136664774E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.700135823876371E-04 0.551772226738393E-04 0.244395750290226E+03 0.124564824864754E-02 0.264274160830927E+03	AVE 0.700098886849331E-04 0.551711041397082E-04 0.244395797157950E+03 0.124560775837283E-02 0.264273500344114E+03
NORMS AT NSTEP CNT4 120	NORMS AT NSTEP CNT4 120
SPECTRAL NORMS - LOG(PREHYDS) 0.114976702353364E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114976700203305E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.697382741480206E-04 0.549996359928514E-04 0.244410906797632E+03 0.124605874721983E-02 0.264480263413646E+03	AVE 0.697396033282673E-04 0.550060586363612E-04 0.244410958264219E+03 0.124601674828743E-02 0.264480018239692E+03

Further mitraillette tests of AA1T configuration showed a dependency of the spectral norms to the NPROMA values in mono processing jobs as detailed in the following table:

AL39T1.03 - NPROMA=-1790	AL39T1.03 - NPROMA=-92	AL39T1.03 - NPROMA=-3582
NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114939063186121E+02 OROGRAPHY 0.300349554410728E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.114939063190822E+02 OROGRAPHY 0.300349554410728E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.114939063184450E+02 OROGRAPHY 0.300349554410728E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.705863446540570E-04 0.499206396163901E-04 0.244650185091269E+03 0.131648657840734E-02 0.285197607587348E+03	AVE 0.705861902373722E-04 0.499206603539596E-04 0.244650184746479E+03 0.131648616224686E-02 0.285197646113632E+03	AVE 0.705861590363605E-04 0.499207644930925E-04 0.244650185835719E+03 0.131648621605339E-02 0.285197567327398E+03
NORMS AT NSTEP CNT4 5	NORMS AT NSTEP CNT4 5	NORMS AT NSTEP CNT4 5
SPECTRAL NORMS - LOG(PREHYDS) 0.114939242060558E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114939227369973E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114939227365194E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.714289358811784E-04 0.513157940943400E-04 0.244611623897472E+03 0.131324963841057E-02 0.284019080379600E+03	AVE 0.714940952853690E-04 0.513815835698252E-04 0.244610417961305E+03 0.131394457478834E-02 0.284067193583812E+03	AVE 0.714941883191409E-04 0.513813754180353E-04 0.244610416819292E+03 0.131394427298258E-02 0.284067315819988E+03
NORMS AT NSTEP CNT4 115	NORMS AT NSTEP CNT4 115	NORMS AT NSTEP CNT4 115
SPECTRAL NORMS - LOG(PREHYDS) 0.114976138745886E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114976136711997E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114976138624140E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.700060930049433E-04 0.551621377394172E-04 0.244395919764925E+03 0.124575121763597E-02 0.264264809511056E+03	AVE 0.700083720989475E-04 0.551643396982186E-04 0.244395773365152E+03 0.124559497317129E-02 0.264272227838468E+03	AVE 0.700135823876371E-04 0.551772226738393E-04 0.244395750290226E+03 0.124564824864754E-02 0.264274160830927E+03

These differences were not detected with ALARO configuration in the cy39_main since there were no NPROMA dependency and also bit reproducibility between mono and multi-processing jobs.

After discussions between the phasing team, we decided to make some new mitraillette tests using a new binary based on the main pack but including the modifications of ALARO model, which were introduced to the cy39_t1 pack.

These tests showed that the non reproducibility problem can be fixed by introducing some arrays initialization in APLPAR routine, which have been added by B. Radmila.

Therefore, the ALARO fix modification consisted in including the following arrays initialization in the file arp/phys_dmn/aplpar.F90:

```
ZRHS (:,:)   = 0.0_JPRB
ZLML1 (:,:)   = 0.0_JPRB
ZTAUITKE(:,:) = 1.0_JPRB
ZKERV(:,:)   = 1.0_JPRB
```

Further tests, which consisted on initializing these arrays separately showed that the initialization of the first array (ZRHS) can resolve this NPROMA dependency problem.

We suggested this fix to be introduced in the cy39_t1.04 version, so a clearcase branch based on the cy39_t1.03 and including the modified aplpar.F90 file was created, it's named “arp_sassi_CY39_alaro-fx”.

3/ Validation of al39_T1.04 :

The last version for validation, Al39_t1.04, containing the fix of ALARO and other contributions was released on march 12. Mitraillette tests were turned using this version compared to the reference pack (Al39_main.01) and showed the following results:

AL39	AL39T1
AH5E	
TEST OF THE TANGENT LINEAR	TEST OF THE TANGENT LINEAR
LAMBDA = -8	LAMBDA = -8
PRES. I = 1 RAT = 0.1004908891024094E+01 -.28422E-13 0.11510E+02 0.11510E+02 0.11510E+02 -.28283E-05 -.11301E-04 0.11510E+02	PRES. I = 1 RAT = 0.1004908891024094E+01 -.28422E-13 0.11510E+02 0.11510E+02 0.11510E+02 -.28283E-05 -.11301E-04 0.11510E+02
VORT. I = 3817 RAT = 0.1000003672289241E+01 0.37219E-14 0.55078E-06 0.59411E-06 0.59411E-06 0.37219E-06 0.62450E-06 0.55078E-06	VORT. I = 3817 RAT = 0.1000003672289241E+01 0.37219E-14 0.55078E-06 0.59411E-06 0.59411E-06 0.37219E-06 0.62450E-06 0.55078E-06
VORT. I = 7633 RAT = 0.9999506212685806E+00 0.73323E-15 -.20148E-06 -.23031E-06 -.23031E-06 0.73326E-07 0.28374E-06 -.20148E-06	VORT. I = 7633 RAT = 0.9999506212685806E+00 0.73323E-15 -.20148E-06 -.23031E-06 -.23031E-06 0.73326E-07 0.28374E-06 -.20148E-06
AH4E	
TEST OF THE ADJOINT	TEST OF THE ADJOINT
1,234568E+19	1,234568E+19
< F(X) , Y > = 0.45181675019687946720E-02	< F(X) , Y > = 0.45181675019687946720E-02
< X , F*(Y) > = 0.45181675019687929400E-02	< X , F*(Y) > = 0.45181675019687929400E-02
THE DIFFERENCE IS 1.729 TIMES THE ZERO OF THE MACHINE	THE DIFFERENCE IS 1.729 TIMES THE ZERO OF THE MACHINE
AH6E	
TQLB exited with IERR = 0	TQLB exited with IERR = 0
TQLB delivered... J = 1 FIRST = 2 LAST = 1	TQLB delivered... J = 1 FIRST = 2 LAST = 1
ID1 = 1 L = 1 I = 1 |BND|^2 = 1.00000000000000D+00	ID1 = 1 L = 1 I = 1 |BND|^2 = 1.00000000000000D+00
I RITZ(I) (BND(I)) ALF(I) BET(I)	I RITZ(I) (BND(I)) ALF(I) BET(I)
1 1.17515361694795D+00 (1.00000000000000D+00) 1.175D+00 2.356D-09	1 1.17515361694795D+00 (1.00000000000000D+00) 1.175D+00 2.356D-09
DSORT2 delivered...	DSORT2 delivered...
1 1.17515361694795D+00 (4.20598182669482D-01)	1 1.17515361694795D+00 (4.20598182669482D-01)
J ** RITZ ** EIG=SQRT(ABS(RITZ)) ** BND	J ** RITZ ** EIG=SQRT(ABS(RITZ)) ** BND
1 0.117515361695E+01 0.108404502533E+01 0.420598182669E+00 ** OK ** 0.3579E-03	1 0.117515361695E+01 0.108404502533E+01 0.420598182669E+00 ** OK ** 0.3579E-03
AH8E019	
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9948408407274573
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9990354686741160

GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9999309810771044
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9999930049187090
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9999986769644720
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9999971335232737
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9999719306626423
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9997193362269819
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9971933786867416
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.9719337841836601
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= 0.7193376541322009
GRTEST gradient T1= 0.9948408407274573	GRTEST gradient T1= -1.806498386513473

ARUT

NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114824662574855E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114824662574855E+02
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.000000000000000E+00 0.000000000000000E+00 0.242830409486086E+03 0.500000000000000E+02	AVE 0.000000000000000E+00 0.000000000000000E+00 0.242830409486086E+03 0.500000000000000E+02
NORMS AT NSTEP CNT4 1	NORMS AT NSTEP CNT4 1
SPECTRAL NORMS - LOG(PREHYDS) 0.114824662574855E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114824662574855E+02
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.000000000000000E+00 0.000000000000000E+00 0.242828847889810E+03 0.498322210926834E+02	AVE 0.000000000000000E+00 0.000000000000000E+00 0.242828847889808E+03 0.498322210926834E+02
NORMS AT NSTEP CNT4 2	NORMS AT NSTEP CNT4 2
SPECTRAL NORMS - LOG(PREHYDS) 0.114824662574855E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114824662574855E+02
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.000000000000000E+00 0.000000000000000E+00 0.242827310674709E+03 0.497240459873622E+02	AVE 0.000000000000000E+00 0.000000000000000E+00 0.242827310674706E+03 0.497240459873822E+02
NORMS AT NSTEP CNT4 60	NORMS AT NSTEP CNT4 60
SPECTRAL NORMS - LOG(PREHYDS) 0.114824662574855E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114824662574855E+02
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.000000000000000E+00 0.000000000000000E+00 0.242800958578169E+03 0.481659882377118E+02	AVE 0.000000000000000E+00 0.000000000000000E+00 0.242800891216157E+03 0.481682915506042E+02

AH9E

NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114898578791594E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114898578791594E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.471546084159085E-04 0.212015760420401E-04 0.242533106127447E+03 0.193243168166620E-02 0.230214267390242E+03	AVE 0.471546084159085E-04 0.212015760420401E-04 0.242533106127447E+03 0.193243168166620E-02 0.230214267390242E+03

AHFE

NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114992390532891E+02 OROGRAPHY 0.308180803967619E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.114992390532891E+02 OROGRAPHY 0.308180803967619E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.718634088080825E-04 0.494155124965561E-04 0.240426017772481E+03 0.101779989814806E-02 0.507004653185457E+03	AVE 0.718634088080825E-04 0.494155124965561E-04 0.240426017772481E+03 0.101779989814806E-02 0.507004653185457E+03

AG1T

NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.115093445868813E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.115093444147061E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.475829399503399E-04 0.349315308795090E-04 0.246833638991243E+03 0.151890006807550E-02 0.138097132164668E+03	AVE 0.475917478354349E-04 0.349260349010091E-04 0.246833537448083E+03 0.151898285818887E-02 0.138106054823251E+03
NORMS AT NSTEP CNT4 96	NORMS AT NSTEP CNT4 96

SPECTRAL NORMS - LOG(PREHYDS) 0.115091777396932E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.115091747559684E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.485070678555386E-04 0.387482724560135E-04 0.246871548789360E+03 0.148096462412259E-02 0.158217003345556E+03	AVE 0.486292931917657E-04 0.387618160809375E-04 0.246873418857434E+03 0.148199860186444E-02 0.158234772344741E+03

AGIT

NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.103508304841919E-03 OROGRAPHY 0.308180803967619E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.103508304841919E-03 OROGRAPHY 0.308180803967619E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.100900065999243E-04 0.929566359746782E-05 0.139610436890821E+00 0.429215445754950E-04 0.104460628726127E+00	AVE 0.100900065999243E-04 0.929566359746782E-05 0.139610436890821E+00 0.429215445754950E-04 0.104460628726127E+00
NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.115000729370212E+02 OROGRAPHY 0.308180803967619E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.149633434025254E-03 OROGRAPHY 0.308180803967619E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.373726308826702E-04 0.226350382906088E-04 0.250225249310976E+03 0.189577360371769E-02 0.178578371284337E+03	AVE 0.373726308826702E-04 0.226350382906088E-04 0.250225249310976E+03 0.189577360371769E-02 0.178578371284337E+03

AA1T066

NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114939054727716E+02 OROGRAPHY 0.300349554410728E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.114939063184450E+02 OROGRAPHY 0.300349554410728E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.705854830365691E-04 0.499197637338880E-04 0.244650295839856E+03 0.131627372888052E-02 0.285197626166177E+03	AVE 0.705861590363605E-04 0.499207644930925E-04 0.244650185835719E+03 0.131648621605339E-02 0.285197567327398E+03
NORMS AT NSTEP CNT4 120	NORMS AT NSTEP CNT4 120
SPECTRAL NORMS - LOG(PREHYDS) 0.114976700739546E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114976700203305E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.697032489372186E-04 0.549670981637591E-04 0.244410943640306E+03 0.124618802228202E-02 0.264477494227121E+03	AVE 0.697396033282673E-04 0.550060586363612E-04 0.244410958264219E+03 0.124601674828743E-02 0.264480018239692E+03

AR1T

NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114848609196616E+02 OROGRAPHY 0.399316573203574E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.114848609196616E+02 OROGRAPHY 0.399316573203574E+04
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.852556942475648E-04 0.809947694606324E-04 0.256351366366780E+03 0.288086256138754E+03	AVE 0.852556942475648E-04 0.809947694606324E-04 0.256351366366780E+03 0.288086256138754E+03
NORMS AT NSTEP CNT4 1	NORMS AT NSTEP CNT4 1
SPECTRAL NORMS - LOG(PREHYDS) 0.114848580366639E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114848580366772E+02
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.856943357945765E-04 0.990723842610016E-04 0.256345417901333E+03 0.288195770651638E+03	AVE 0.856599232293543E-04 0.990629271117537E-04 0.256345414092091E+03 0.288197540732631E+03
NORMS AT NSTEP CNT4 240	NORMS AT NSTEP CNT4 240
SPECTRAL NORMS - LOG(PREHYDS) 0.114839818080650E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114839818443012E+02
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.156994984941599E-03 0.145978793862156E-03 0.255438468970612E+03 0.272596396660767E+03	AVE 0.156916677783621E-03 0.145929807393430E-03 0.255437465913279E+03 0.272639462951531E+03

This AROME configuration run shows different spectral norms between the third and the fourth versions. This difference was not observed for the other configurations.
A run while switching off the namelist key of activation of cloud droplet sedimentation (LOSEDIC) showed a bit identity between the third and fourth versions spectral norms.

The following pictures show the difference values of the cloud water content and the zonal wind at the 30th level altitude:

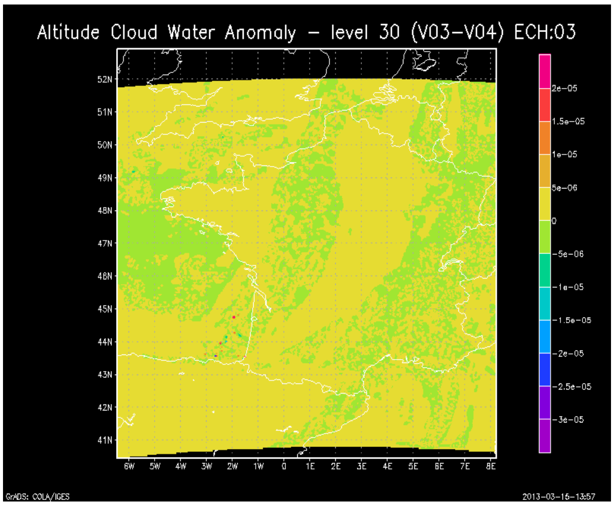

Figure 19: Altitude Cloud Water Anomaly – level 30 (al39_T1.03 – al39_T1.04)

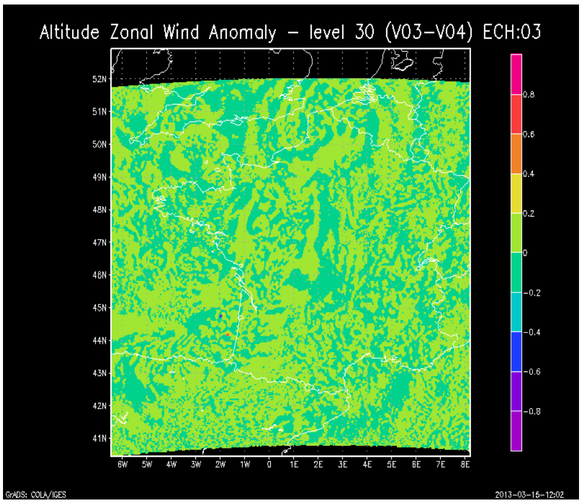

Figure 20: Zonal Altitude Wind Anomaly – level 30 (al39_T1.03 – al39_T1.04)

We tried to understand the reason of these differences, some tests were made upon the modified routines (arrays initialization, switch on/off same namelist variables) but the spectral norms difference persisted. More tests need to be made for this issue.

III. Fix of norm violations :

This part consisted on fixing some norm violations reported by the norm checker. A sample of these violations is the following:

```
========== Working on file acmixelen.F90 ==========
acmixelen.F90[175] : LOGICAL   :: LDMAF
  -- (S) 4.17 : All dummy arguments must specify the INTENT attribute

========== Working on file actkehmtls.F90 ==========
actkehmtls.F90[129] : USE YOMPHY2  , ONLY : TSPHY    , XMULAF  ,GZ0RAF   ,FACRAF
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "FACRAF" found in USE YOMPHY2, ONLY: ... but not used

actkehmtls.F90[129] : USE YOMPHY2  , ONLY : TSPHY    , XMULAF  ,GZ0RAF   ,FACRAF
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "GZ0RAF" found in USE YOMPHY2, ONLY: ... but not used

========== Working on file acmrip.F90 ==========
acmrip.F90[633] :        IF (ZRITKE.lt.0) THEN
  -- (W) 4.15 : Use Fortran90 comparison operators
  -- Relational operator "<" preferred to ".LT."

acmrip.F90[645] :        END IF
  -- (W) 4.19.a : END statement for blocks should not have a space after END

acmrip.F90[113] : USE YOMCST   , ONLY : RG      ,RD      ,RKAPPA    ,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "RATM" found in USE YOMCST, ONLY: ... but not used

acmrip.F90[111] : USE YOMPHY   , ONLY : LRRGUST  ,L3MT  ,LSTRAPRO,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "LCOEFK_CCH02A" found in USE YOMPHY, ONLY: ... but not used

acmrip.F90[118] : USE YOMPHY0  , ONLY : ALMAV    , VKARMN  ,ENT_LAMBDA,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "C_EPSILON" found in USE YOMPHY0, ONLY: ... but not used

acmrip.F90[113] : USE YOMCST   , ONLY : RG      ,RD      ,RKAPPA    ,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "RPI" found in USE YOMCST, ONLY: ... but not used

========== Working on file acnebnsc.F90 ==========
```

```
acnebnsc.F90[111] : USE YOMPHY0  , ONLY : QSNEBC   ,QSNEBS   ,QSSUSC   ,QSSUSS,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "QSUSXC" found in USE YOMPHY0, ONLY: ... but not used

acnebnsc.F90[111] : USE YOMPHY0  , ONLY : QSNEBC   ,QSNEBS   ,QSSUSC   ,QSSUSS,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "QXRHX" found in USE YOMPHY0, ONLY: ... but not used

acnebnsc.F90[111] : USE YOMPHY0  , ONLY : QSNEBC   ,QSNEBS   ,QSSUSC   ,QSSUSS,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "QSSUSC" found in USE YOMPHY0, ONLY: ... but not used

acnebnsc.F90[111] : USE YOMPHY0  , ONLY : QSNEBC   ,QSNEBS   ,QSSUSC   ,QSSUSS,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "RQLCV" found in USE YOMPHY0, ONLY: ... but not used

acnebnsc.F90[111] : USE YOMPHY0  , ONLY : QSNEBC   ,QSNEBS   ,QSSUSC   ,QSSUSS,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "QSNEBS" found in USE YOMPHY0, ONLY: ... but not used

acnebnsc.F90[111] : USE YOMPHY0  , ONLY : QSNEBC   ,QSNEBS   ,QSSUSC   ,QSSUSS,
  -- (W) 2.4 : Declarations of unused variables must be removed
  -- Variable "QSNEBC" found in USE YOMPHY0, ONLY: ... but not used
```

The main violations were about :

- Declaration of non used variables ;
- Variable names not following prefix convention as defined in the programming standard document ;
- Syntax issues like use of "END IF" in order of "ENDIF" or use of ".NE." in order of "/=".

ect...

The modified files are:

arp/op_obs/slint_canari.F90
arp/phys_dmn/accvud.F90
arp/phys_dmn/acdifv3.F90
arp/phys_dmn/acmixelen.F90
arp/phys_dmn/acmrip.F90
arp/phys_dmn/acmris.F90
arp/phys_dmn/acmriss.F90
arp/phys_dmn/acnebcond.F90
arp/phys_dmn/acnebnsc.F90
arp/phys_dmn/acpscc.F90
arp/phys_dmn/acptke.F90
arp/phys_dmn/acptkes.F90
arp/phys_dmn/actkecoefkh.F90
arp/phys_dmn/actkehmt.F90
arp/phys_dmn/actkehmtls.F90
arp/phys_dmn/actkezot.F90
arp/phys_dmn/actkezotls.F90
arp/phys_dmn/arp_ground_param.F90
arp/phys_dmn/suphy0.F90
arp/phys_dmn/vdfparcelhl.F90
arp/phys_radi/surrtmcf.F90
arp/phys_radi/susrtmcf.F90
arp/var/readtmp.F90

To verify the neutrality of the above modifications, a mitraillette test with physics was ran and the numerical reproducibility was verified.

These modified files were then stored in a new branch under clearcase, based on the cy39_t1.02 version and called “arp_sassi_CY39_norms_vio”.

IV. Code cleaning :

The basic idea about this cleaning work is to remove some subroutines which can be easily incorporated inside other model routines. For example we can consider the EINTFAC subroutine, which deals with the mean wind arrays in case of LELAM models. This subroutine is called from few routines such as dfi2.F90.

The main role of this subroutine consisted on copying the arrays of mean wind fields from the global model to the limited area one, or from the limited area model to the global one. While checking the call tree of this subroutine, only the three following files were identified:

1/ arp/dfi/dfi2.F90 ;
2/ arp/dfi/digfil.F90;
3/ arp/dfi/dfi2mod.F90.

The call of EINTFAC subroutine was also associated with a change of variables, which enables to avoid the use of LELAM defined ones. As an example, the SPA1 pointer of mean wind arrays for ALADIN model, defined in the YOMSP module, does not appear in the global model routine arrays, but changed by the ZUVAVG variable, every time the EINTFAC subroutine is called. Therefore, to apply the idea of EINTFAC removal, this variable change was avoided and the SPA1 array was directly handled inside the DFI routines.

In addition to EINTFAC subroutine, two more subroutines were removed; SUFPPHQ.F90 and GPINITHER.F90.
The SUFPPHQ subroutine enables the control of physical quantities post-process. It's called from the arp/setup/sumts.F90 routine.
The GPINITHER subroutine initializes the weight vectors and is called from the arp/phys_dmn/mf_phys.F90 routine which enables the call of Meteo-France physics.

Validation of in-linings:

To validate the inline work, some mitraillette tests have been realized, then spectral norms have been compared to prove the neutrality of modifications:

- EINTFAC: To verify the neutrality of EINTFAC subroutine removal, four configurations were turned with mitraillette; AA1T, AG1T, AGIT and AR1T including DFI. To turn DFI on in AROME configuration, the key LDFI was set to TRUE in namelist, and the following parameters were chosen: NSTDFI=5 and TAUS=900.
  This run gave bit identity as described in the following table between the original version of al39_t1.03 and the modified new one:

AL39_T1.03	**AL39_T1.03_new**
AA1T	AA1T
NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114939063184450E+02 OROGRAPHY 0.300349554410728E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.114939063184450E+02 OROGRAPHY 0.300349554410728E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.705861590363605E-04 0.499207644930925E-04 0.244650185835719E+03 0.131648621605339E-02 0.285197567327398E+03	AVE 0.705861590363605E-04 0.499207644930925E-04 0.244650185835719E+03 0.131648621605339E-02 0.285197567327398E+03
NORMS AT NSTEP CNT4 120	NORMS AT NSTEP CNT4 120
SPECTRAL NORMS - LOG(PREHYDS) 0.114976700203305E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114976700203305E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.697396033282673E-04 0.550060586363612E-04 0.244410958264219E+03 0.124601674828743E-02 0.264480018239692E+03	AVE 0.697396033282673E-04 0.550060586363612E-04 0.244410958264219E+03 0.124601674828743E-02 0.264480018239692E+03
AG1T	AG1T
NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.115093444147061E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.115093444147061E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY

AVE 0.475917478354349E-04 0.349260349010091E-04 0.246833537448083E+03 0.151898285818887E-02 0.138106054823251E+03	AVE 0.475917478354349E-04 0.349260349010091E-04 0.246833537448083E+03 0.151898285818887E-02 0.138106054823251E+03
NORMS AT NSTEP CNT4 96	NORMS AT NSTEP CNT4 96
SPECTRAL NORMS - LOG(PREHYDS) 0.115091747559684E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.115091747559684E+02
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.486292931917657E-04 0.387618160809375E-04 0.246873418857434E+03 0.148199860186444E-02 0.158234772344741E+03	AVE 0.486292931917657E-04 0.387618160809375E-04 0.246873418857434E+03 0.148199860186444E-02 0.158234772344741E+03
AGIT	AGIT
NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.103508304841919E-03 OROGRAPHY 0.308180803967619E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.103508304841919E-03 OROGRAPHY 0.308180803967619E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.100900065999243E-04 0.929566359746782E-05 0.139610436890821E+00 0.429215445754950E-04 0.104460628726127E+00	AVE 0.100900065999243E-04 0.929566359746782E-05 0.139610436890821E+00 0.429215445754950E-04 0.104460628726127E+00
NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.115000729370212E+02 OROGRAPHY 0.308180803967619E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.149633434025254E-03 OROGRAPHY 0.308180803967619E+04
LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE HUMIDITY KINETIC ENERGY
AVE 0.373726308826702E-04 0.226350382906088E-04 0.250225249310976E+03 0.189577360371769E-02 0.178578371284337E+03	AVE 0.373726308826702E-04 0.226350382906088E-04 0.250225249310976E+03 0.189577360371769E-02 0.178578371284337E+03
AL39_T1.03	**AL39_T1.03_new (Including DFI)**
AR1T	AR1T
NORMS AT NSTEP CNT4 0	NORMS AT NSTEP CNT4 0
SPECTRAL NORMS - LOG(PREHYDS) 0.114848615900448E+02 OROGRAPHY 0.399316573203574E+04	SPECTRAL NORMS - LOG(PREHYDS) 0.114848615900448E+02 OROGRAPHY 0.399316573203574E+04
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.868665063498536E-04 0.927536855002595E-04 0.256354554407350E+03 0.287542080676245E+03	AVE 0.868665063498536E-04 0.927536855002595E-04 0.256354554407350E+03 0.287542080676245E+03
NORMS AT NSTEP CNT4 240	NORMS AT NSTEP CNT4 240
SPECTRAL NORMS - LOG(PREHYDS) 0.114839766584098E+02	SPECTRAL NORMS - LOG(PREHYDS) 0.114839766584098E+02
LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY	LEV VORTICITY DIVERGENCE TEMPERATURE KINETIC ENERGY
AVE 0.155820958183603E-03 0.145542932053439E-03 0.255434625999564E+03 0.272796810032797E+03	AVE 0.155820958183603E-03 0.145542932053439E-03 0.255434625999564E+03 0.272796810032797E+03

- SUFPPHQ: After removing the SUFPPHQ subroutine, mitraillette tests of AHFE and AH9E configurations were run while setting NFPOS value different from zero.
- GPINITHER: The neutrality of the removal of GPINITHER subroutine had been verified with the run of AA1T, AG1T, AGIT and AR1T configurations while setting the LSDDH key to FALSE in namelist.

The comparison of spectral norms showed bit identity after this in-lining work.