PHASING REPORT
pre-cycle 41

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This report is an attempt to assemble our phasing work on PRE-CY41.

What's new :

CY40R2 is a technical cycle which will be merged with CY40T1 from Météo-France to make CY41. The cycle contains modifications to run on ECMWF Cray, latest OOPS-IFS encapsulations and geometry refactoring, many satellite contributions and also RTTOV-11.

Phasing work :

Our base cycle for phasing was cy40t1_r2 prepared by Stéphane.

An extensive list of LAM routines using moved variables or recently encapsulated variables was prepared. In particular, all 'aladin' routines using modules YOMCT0, YOMGC, YOMGEM, YOMDIM, YOMDIMV, YOMMP, YOMVERTFE, YOMSTA, YOMSTADLR, YOMLAP and YEMLAP were checked and updated accordingly to the new modern encapsulation structure (the variables of each module are put in a derived type).

The Fortran 2003 ASSOCIATE construct was used to limit the changes to the source code of the model.

List of LAM modified routines :

aladin/adiab/espchor.F90
aladin/adiab/espchorad.F90
aladin/adiab/espcsi.F90
aladin/adiab/espcsiad.F90
aladin/adiab/especrt.F90
aladin/adiab/espnhsi.F90
aladin/adiab/espnhsi_geogw.F90
aladin/c9xx/ebicli.F90
aladin/c9xx/echk923.F90
aladin/c9xx/ecoptra.F90
aladin/c9xx/eganiso.F90
aladin/c9xx/egeo923.F90
aladin/c9xx/eincli1.F90
aladin/c9xx/eincli10.F90
aladin/c9xx/eincli2.F90
aladin/c9xx/eincli3.F90
aladin/c9xx/eincli4.F90

aladin/c9xx/eincli5.F90
aladin/c9xx/eincli6.F90
aladin/c9xx/eincli7.F90
aladin/c9xx/eincli8.F90
aladin/c9xx/eincli9.F90
aladin/c9xx/einter0.F90
aladin/c9xx/eleci.F90
aladin/control/espcm.F90
aladin/control/espcmad.F90
aladin/coupling/ecoupl1.F90
aladin/coupling/ecoupl1ad.F90
aladin/coupling/elswa3.F90
aladin/coupling/erlbc.F90
aladin/coupling/eseimpls.F90
aladin/coupling/eseimplsad.F90
aladin/coupling/etenc.F90
aladin/dia/ewmovph.F90
aladin/fullpos/ebipos.F90
aladin/fullpos/fpezone.F90
aladin/fullpos/suefpg3.F90
aladin/fullpos/sufpezo.F90
aladin/fullpos/sufpmove.F90
aladin/interpol/elascaw.F90
aladin/interpol/elascawtl.F90
aladin/parallel/ecommjbbalbeta.F90
aladin/parallel/ecommspnorm.F90
aladin/parallel/egathereigmd.F90
aladin/programs/holo.F90
aladin/programs/unholo.F90
aladin/setup/elsac.F90
aladin/setup/esp2lnsp.F90
aladin/setup/suedim.F90
aladin/setup/suedyn.F90
aladin/setup/suehdf.F90
aladin/setup/suehdvpn.F90
aladin/setup/sueheg.F90
aladin/setup/sueinif.F90
aladin/setup/sueldynb.F90
aladin/setup/suenhheg.F90
aladin/setup/sueorog.F90
aladin/setup/sueqlimsat.F90
aladin/setup/suezone.F90
aladin/sinvect/echnorm.F90
aladin/transform/etransdir_mdl.F90
aladin/transform/etransdir_mdlad.F90
aladin/transform/etransinv_jbtomodel.F90
aladin/transform/etransinv_jbtomodelad.F90
aladin/transform/etransinv_mdl.F90
aladin/transform/etransinv_mdlad.F90
aladin/transform/euvgeovd.F90

aladin/transform/evduvgeo.F90
aladin/utility/cchien.F90
aladin/utility/deello.F90
aladin/utility/espareord.F90
aladin/utility/espconvert.F90
aladin/utility/euvcopy.F90
aladin/var/ebalbetaad.F90
aladin/var/ebalnonlin.F90
aladin/var/ebalnonlinad.F90
aladin/var/ebalomega.F90
aladin/var/ebalomegatl.F90
aladin/var/ebalvert.F90
aladin/var/ebalvertad.F90
aladin/var/ebalverti.F90
aladin/var/ebalvertiad.F90
aladin/var/ecosjr.F90
aladin/var/ecvaru2i.F90
aladin/var/ecvaru2iad.F90
aladin/var/edog.F90
aladin/var/efill_isotropic.F90
aladin/var/ejghcor.F90
aladin/var/ejghcori.F90
aladin/var/escaljgs.F90
aladin/var/evarjk.F90
aladin/var/evarjkad.F90
aladin/var/evarjkini.F90
aladin/var/ewrlsgrad.F90
aladin/var/suejbbal.F90
aladin/var/suejbbalbeta.F90
aladin/var/suejbcor.F90
aladin/var/suejbcosu.F90
aladin/var/suejbcov.F90
aladin/var/suejbdat96.F90
aladin/var/suejbstd.F90
aladin/var/suejbtest.F90
aladin/var/suejknorm.F90
aladin/var/suelges.F90
aladin/var/suelljk.F90
aladin/var/suemodjk.F90
aladin/var/suescal.F90
aladin/var/suevargp.F90
aladin/wavelet/ejbwav_cv2wav.F90
aladin/wavelet/ejbwav_gp2wav.F90
aladin/wavelet/ejbwav_h2v.F90
aladin/wavelet/ejbwav_v2h.F90
aladin/wavelet/ejbwav_vcori.F90
aladin/wavelet/ejbwav_wav2cv.F90
aladin/wavelet/ejbwav_wav2gp.F90
aladin/wavelet/suejbwav_read_eigval.F90
aladin/wavelet/suejbwav_read_eigvec.F90

aladin/wavelet/suejbwav_read_sigmab.F90
aladin/wavelet/suejbwavalloc.F90

List of non LAM modified routines :

arpifs/module/yemlap.F90
arpifs/setup/suinif.F90

List of added routines :

aladin/transform/etransinvh_oops.F90
aladin/utility/deello_geometry.F90

The new routine `deello_geometry.F90` was created. Its purpose is to deallocate the `YRLEP` structure. It is called in `aladin/utility/deello.F90`.

The new routine `etransinvh_oops.F90` was added. Its purpose is to simulate the same behavior as new arp/ifs routine `transinvh_oops.F90`, in case of LAM model (L_OOPS=.TRUE.).

`aladin/adiab/especrt.F90` and `aladin/control/espcm.F90` were updated to be consistent with John Hague contribution done in `arpifs/adiab/specrt.F90` and `arpifs/control/spcm.F90`.

`arpifs/module/yemlap.F90` was refactored in order to match the modern encapsulation done in YOMLAP.
`arpifs/setup/suinif.F90` was updated so that a proper call to `ESPECRT` is done in the case where `YDSP` is present.

Mitraillette validation :

The references (based on CY40T1) are those made by Karim Yessad :
`/home/gmap/mrpm/yessadk/SAVE/mitraille/references/`

LAM model outputs of our MITRAILLETTE tests are on beaufix :
mono procs : `/home/gmap/mrpe/jidanem/mitraille/cy40t1r2/mitraille_0021`
multi procs : `/home/gmap/mrpe/jidanem/mitraille/cy40t1r2/mitraille_0022`

Mono procs tests :

All the tests run fine and have bit reproducible results with respect to CY40T1 (reference).

Multi procs tests :

Almost all the tests run fine and have bit reproducible results with respect to the reference.

- Some full-pos tests were crashing in the first tests : (OAHFE066, OAHFE067, OAHFE068, OAHFE069, OAHFE072 and OAHFE073)

  ```
  SUFPC: If NFPOS/=0 and NFPCLI/=3, LSURF_CLASSIC should be F
  ```

K. Yessad updated all his namelists so that LSURF_CLASSIC had the right value depending on the value of NFPCLI :

LSURF_CLASSIC=.TRUE. if NFPCLI=3
LSURF_CLASSIC=.FALSE. otherwise

This has resolve the problem of the setup in FULLPOS.

- The tests of the e801 configurations, which crashes in the reference, run without problem but results are difficult to check, the usual printouts have disappeared from the listing.

- The tests with the rotated tilted Mercator projection crash as in reference CY40T1 (OAC1U082, OAC5T083 and OAC5T084 : WIND TOO STRONG).

- After few corrections, tests of AHFE full-pos were crashing :

  SUEFPG3 : THERE ARE POINTS OUT OF THE DOMAIN

  The problem was in routines sufpd.F90 and suegem_naml.F90. The reorganization of those routines creates a bug. Variables ELONC, ELATC, ELAT1, ELON2, ELAT2, ELON0, ELAT0, EDELX and EDELY from module YEMGEO were read from namelist and recomputed in sufpd.F90 and in suegem_naml.F90. Now they are read only in suegem_naml.F90. The bug was due to often recomputation of those variables from degrees to radians, and some of them may sometimes be stored also in meters (EDELX and EDELY). Because of it, the code was very difficult to read and it was easy to make a mistake. To prevent that, those routines were corrected. Printouts were changed to tell in which units variables are stored and also few new variables was created to check if units are correct. The corrected code will be part of v3 of the pre-cycle libraries in Toulouse (CY40T1_r2.03, to be built on 29 April).

- **<u>OAN1T049 issue :</u>**

The run is ok but there is some small differences in spectral norms :
We think that may be there is a bug in the set up of vertical geometry in the case of Vertical Finite Elements (LVERTFE) Non-Hydrostatic Adiabatic E001 with SL2TL advection scheme, or may be it's just numerical differences, we don't know for sure.

PRE-CY41	**REFERENCE**
----- SUVERTFEB ---------------- VFE second derivative operator input splines, order: 4 number: 17 output splines, order: 4 number: 17 weighting splines, order: 4 number: 17 SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SHAPE Z_W : 17 4 4	----- SUVERTFEB ---------------- VFE second derivative operator input splines, order: 4 number: 17 output splines, order: 4 number: 17 weighting splines, order: 4 number: 17 SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SHAPE Z_W : 17 4 4

SHAPE Z_IN : 17 4 4	SHAPE Z_IN : 17 4 4
SHAPE Z_OUT: 17 4 4	SHAPE Z_OUT: 17 4 4
INTEGRAL OF VDELB= 1.00000000000000	INTEGRAL OF VDELB= 1.00000000000000
ITERATION 1 , INTEGRAL OF VDELA=	ITERATION 1 , INTEGRAL OF VDELA=
-218.631324880966	-218.631324880966
ITERATION 2 , INTEGRAL OF VDELA=	ITERATION 2 , INTEGRAL OF VDELA=
-3.49542790844714	-3.49542790844714
ITERATION 3 , INTEGRAL OF VDELA=	ITERATION 3 , INTEGRAL OF VDELA=
-5.611443659506676E-002	-5.611443659324777E-002
AFTER ADJUSTING, INTEGRAL OF VDELA=	AFTER ADJUSTING, INTEGRAL OF VDELA=
-9.009005192410768E-004	-9.009005246980450E-004
INTEGRAL OF 1.= 1.00000000000000	INTEGRAL OF 1.= 1.00000000000000
---- Set up standard atmosphere	---- Set up standard atmosphere
--------------------------------------	--------------------------------------
SUSTA - STANDARD ATMOSPHERE HEIGHT	SUSTA - STANDARD ATMOSPHERE HEIGHT
15 44.7913280348749	15 44.7913280348749
14 184.603339063349	14 184.603339063349
13 553.037891248640	13 553.037891248640
12 1020.00333244383	12 1020.00333244383
11 1632.01545705892	11 1632.01545705891
10 2389.94305647151	10 2389.94305647151
9 3300.62138681907	9 3300.62138681907
8 4374.52661851347	8 4374.52661851346
7 5629.66990174701	7 5629.66990174702
6 7092.93285482365	6 7092.93285482365
5 8808.32055395261	5 8808.32055395260
4 10852.3877169975	4 10852.3877169975
3 13453.2710483873	3 13453.2710483873
2 18109.3971740219	2 18109.3971740219
1 24820.9173878851	1 24820.9173878851
NORMS AT NSTEP CNT4 (PREDICTOR) 0	NORMS AT NSTEP CNT4 (PREDICTOR) 0
SPECTRAL NORMS - LOG(PREHYDS)	SPECTRAL NORMS - LOG(PREHYDS)
0.114714396561720E+02 OROGRAPHY	0.114714396561720E+02 OROGRAPHY
0.585363043533415E+04	0.585363043533415E+04
LEV VORTICITY DIVERGENCE	LEV VORTICITY DIVERGENCE
TEMPERATURE HUMIDITY KINETIC	TEMPERATURE HUMIDITY KINETIC
ENERGY	ENERGY
AVE 0.370642449035366E-04 0.399770452787321E-04	AVE 0.370642449035360E-04 0.399770452787318E-04
0.258098075500628E+03 0.266970756402112E-02	0.258098075500628E+03 0.266970756402112E-02
0.127654427791845E+03	0.127654427791845E+03
LEV LOG(PRE/PREHYD) d4 = VERT DIV + X	LEV LOG(PRE/PREHYD) d4 = VERT DIV + X
AVE 0.159753279914930E-04 0.319158912555546E-04	AVE 0.159753279914734E-04 0.319158912555585E-04

Late phasing additional information about this aspect is provided in the Appendix. See below.

Appendix : Short summary of phasing for AN1T049 job.

As it was said in report of phasing, there are some small differences in spectral norms in **AN1T049**, originated from differences in setup of the model in this configuration:

PRE-CY41	REFERENCE
----- SUVERTFEB ---------------- VFE second derivative operator input splines, order: 4 number: 17 output splines, order: 4 number: 17 weighting splines, order: 4 number: 17 SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SHAPE Z_W : 17 4 4 SHAPE Z_IN : 17 4 4 SHAPE Z_OUT: 17 4 4 INTEGRAL OF VDELB= 1.00000000000000 ITERATION 1 , INTEGRAL OF VDELA= -218.631324880966 ITERATION 2 , INTEGRAL OF VDELA= -3.49542790844714 ITERATION 3 , INTEGRAL OF VDELA= -5.611443659506676E-002 AFTER ADJUSTING, INTEGRAL OF VDELA= -9.009005192410768E-004 INTEGRAL OF 1.= 1.00000000000000	----- SUVERTFEB ---------------- VFE second derivative operator input splines, order: 4 number: 17 output splines, order: 4 number: 17 weighting splines, order: 4 number: 17 SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SUVFE_KNOT: FULL LEVELS EXCEPT CLOSE TO BOUNDARIES SHAPE Z_W : 17 4 4 SHAPE Z_IN : 17 4 4 SHAPE Z_OUT: 17 4 4 INTEGRAL OF VDELB= 1.00000000000000 ITERATION 1 , INTEGRAL OF VDELA= -218.631324880966 ITERATION 2 , INTEGRAL OF VDELA= -3.49542790844714 ITERATION 3 , INTEGRAL OF VDELA= -5.611443659324777E-002 AFTER ADJUSTING, INTEGRAL OF VDELA= -9.009005246980450E-004 INTEGRAL OF 1.= 1.00000000000000

We traced back the computation to see where those differences are first seen:

The table above shows differences in suvert.F90, but they came from suvertfe.F90 and computations of RINTE and RINTBF11. Before that, in suvertfeb.F90 there are differences in output form routine suvfe_cpsplines.F90, and this is first place when we noticed small numerical differences in output.

In suvfe_cpsplines.F90 PSPLINE is calculated in loops. After first iteration all values of PSPLINE are the same for 40_t1 and 40_t1_r2. After the second iteration 4 values in this matrix are different:

PRE-CY41	REFERENCE
0.533333333333333 -7.771561172376096E-016 0.466666666666666 -0.533423301844354	0.533333333333332 -6.661338147750939E-016 0.466666666666670 -0.533423301844356

After next steps of loops those differences are growing.

PSPLINE is used for computaion of ZB and ZA matrices in suvfe_matrix.F90. Later ZB and ZA are used to compute POPER matrix in suvertfeb.F90 and POPER is used for computations of RINTE and RINTBF11.

suvert.F90 => suvertfe.F90 => suvertfeb.F90 => suvfe_cpsplines.F90