

IFS/Arpège Memorandum

From: Claude Fischer (Météo-France)

To: (ECMWF) DR, RD Division & Section Heads

To: (Météo-France) Arpège diffusion list

To: (ALADIN) Piet Termonia

To: (HIRLAM) Daniel Santos-Muñoz

File: RD17-xxx

Subject: Minutes of the IFS/Arpège coordination video-conference meeting held on 28 September 2017.

Participants:

Météo-France: François Bouyssel, Claude Fischer, Ryad El Khatib, Karim Yessad, Stéphane Martinez

ECMWF: Stephen English, Deborah Salmond, Olivier Marsden, Peter Lean, Tomas Wilhelmsson

ALADIN: Daan Degrauwe

HIRLAM: Daniel Santos-Muñoz

1. Adoption of Agenda

adopted

2. Approval of Minutes of meeting of 12 June 2017

approved

3. Review of list of actions from last meeting

1. **MF** to provide EC trace-back information about the SRTM problem/crash encountered in some Arpège PEARP members (this is under investigation in GMAP) => *done; fix agreed and implemented in CY45. Action closed.*
2. **MF (Claude and Yann Michel)** to contact Elias Holm for informing about the suggested implementation of a specific REDNMC_Q namelist coefficient in CY45T1 => *MF have dropped this proposal from their CY45T1 and won't implement it. Action closed.*

3. **Tomas and Ryad** to record details of which versions of the compilers were used in the release notes for each cycle. Possibly start this with CY45 FLUBs => *the information about compiler versions was provided with the FLUB of CY45_main (from both EC and MF). Additional information about the list of versions and labels of various ancillary libraries would be welcome as well (ecCodes, ecKIT, OOPS, etc.). Daan pointed out that the proper version of ECOCLIMAP for the SURFEX surface scheme also should be included. There was furthermore a concern not to overdo this information level. Action on both MF (Claude, Ryad, Stéphane) and EC (Deborah, Tomas) to agree on the content of link and runtime information to be included in FLUBs (versions of libraries, extra data files etc.).*
4. **Steve** to ask Sébastien Massart to send details of experiences related to LSPRT and the humidity fields in the assimilation at 45r1 => *Steve reminded that Sébastien had implemented his fix for the humidity problem seen in the IFS in CY45R1. MF believed that there might be more than one bug in the assimilation codes, possibly active for all model configurations. This could be further discussed. Gérald, Loïk and Etienne are going to visit Sébastien at ECMWF on 20-22 November. Claude will check whether they intend to continue discussing the potential issues with the LSPRT option in the assimilation code. Claude will keep Steve informed. Action open.*
5. **MF (Claude and Philippe)** to contact EC (Deborah and Shahram Najm) and co-ordinate to ensure that MF grib_api developments are included in the main eccodes package. => *several contributions by Philippe have been included in the ecCodes package. One specific aspect is pending an action from MF (IT Dept.) towards WMO, and then a decision by WMO about the inclusion of the LAM grid definitions in GRIB2. So these aspects are "closed". Claude thought that Philippe Marguinaud might have a few improvements available for compacting fields, which perhaps could be sent to Shahram. Claude will check again with Philippe, and then contact Deborah and Shahram. That action open.*
6. **All** to revisit decision on timing of OOPS implementation with regards porting to new HPC. As a side-effect probably, re-assess timing scenarios for CY47 (Early/late) => *see item 10 in the agenda.*

4. MF information about progress and plans of E-suites and cycles

François presented the status of testing of CY42_op2 at MF. This e-suite is now under evaluation at Operations since November 2016, and quite a few problematic aspects have been found since then. In the beginning of July, the new convection scheme for Arpège was switched off. At present, problems in the humidity analysis increment are being investigated, with a focus for the time being on the VarBC specifications for GNSS ZTD and the link with the variances coming from the EDA (AEARP). At present, a switch to operations of this e-suite, if decided, could occur in the end of November (earliest timing).

Steve was interested to get details about the choices for the GNSS VarBC implementation in general, and pointed out that EC had to carefully evaluate the VarBC settings for AIREP in CY45R1 (work by Lars Isaksen).

Action on Steve and François: François to send details about the GNSS VarBC implementation in CY42_op2. Steve to send information about VarBC with AIREP in CY45R1.

The next e-suite will be built around the increase of horizontal resolution for Arpège (around 5km over Europe in the deterministic forecast). An EDA system for Arome is also being planned. François' slides can be obtained from François or Claude on demand.

Claude stressed that MF are facing a very intense cycling and debug activity, with about three versions of the code being tested or in preparation in parallel. Those are CY42_op2 (e-suite), CY43T2_bf (base version for fixing the assimilation configurations) and CY45T1 (next interim cycle in preparation). Note to talk about a version CY43++ which is still being used for OOPS-EnVAR by the assimilation scientists involved. This is a situation which is likely to be at the upper edge limit of sustainable technical code activity, though technical code work probably will continue to require working force in the coming weeks and months. The content and timing of CY45T1 is described in Appendix 1 below.

5. EC information about progress and plans of E-suites and cycles

Steve described the content of CY45R1 and presented figures of several impacts on IFS (for more details, please refer to Steve's slides):

- coupled ocean/atmosphere in HRES (fully in Tropics, partial in extra-Tropics, ORAS5 SST)
- carefully checked DA changes that required a long spin-up (b.c., weak constraint): bias correction changes (AIREP), RTTOV-12 implemented, constrained VarBC
- other model changes, among which improved warm-rain microphysics, smooth version of LSETTSLSVF (note: this was the key to remove the unstable behaviour noticed in the high resolution TL), improved convection and downdrafts in TL/AD, activated lightning parameterization (note: MF asked about details of this scheme), methane oxidation in stratosphere
- other DA and satellite changes: land IR, RS drifts and obs error retuned, BUFR Synop, DBNet FY3C, T-to-Tv bug fixed in change of variable of humidity increment, coastal all-sky MW, OCEAN5 sea ice
- model uncertainty contribution: SPPT revised, SKEB deactivated, reduced amplitude of singular vector perturbations for tropical cyclones, stochastic representation of model error made consistent between EDA and ENS

The build and validation of CY45R1 was well advanced, and a handover from Research to Operations was scheduled for October 2017, with an aim at an operational switch for February 2018.

This cycle will be followed by a CY45R2, which will contain the changes for the overlapping 12h-window 4D-VAR as well as additional OOPS re-factoring. CY45R2 would be built and declared as a Research version by end of December 2017. Handover to Operations was planned for the 2nd quarter of 2018 and a switch to Operations for October 2018.

Action: EC to send MF information about the lightning parameterization in CY45R1.

6. Outlook towards the build of CY46

See item 10.

7. HIRLAM comments

none.

8. ALADIN comments

none.

9. Specific issues:

9.1. OOPS Progress

This item was little covered, in the details, during this coordination meeting. A specific technical videoconference took place on Tuesday 26 September, where all specific details of progress and plans about OOPS and IFS re-factoring have been addressed. One aspect worth to stress is that the EC team now is able to run a (reduced) OOPS-IFS 4D-VAR with multiple inner loops (though for the time being at constant horizontal resolution). This is a further progress with respect to June (single loop was working).

Minutes of the 26 September meeting can be obtained from Deborah or Claude.

9.2. removal of the “deep atmosphere assumption” code from IFS/Arpège

K. Yessad introduced the deep-layer formulation of the hydrostatic model in 2001 (option LVERCOR) and the deep-layer formulation of the NHEE model (fully elastic non-hydrostatic model) in 2008 during his stay at ECMWF (options LRWSDLR+LRWSDLW). The LVERCOR and LRWSDLR formulations are significantly different. The LVERCOR formulation is now outdated; the LRWSDLR formulation requires a variable change for hydrostatic pressure which is source of issues for file reading/writing and physics interfaces.

The current coding of the NHQE model (quasi-elastic non-hydrostatic model) will not include deep-layer effects: the deep-layer formulation has not been studied but it is clear that it should preserve the quasi-elastic constraint. However, some terms are significantly different from the NHEE equations, in particular the pressure gradient term and the RHS of the "w" equation. Therefore, what was done for the NHEE equations cannot be easily transposed to the NHQE system.

Tests with the deep-layer formulations in the hydrostatic primitive equations (HPE) and the NHEE models have not shown any improvement in the scores. No one currently uses these formulations in their operational system and no one plans to use them, to our present knowledge.

Deep-layer formulations bring a significant number of additional pieces of code which make the code more difficult to read and to maintain, in particular for the LRWSDLR option. Future code developments or re-shaping may have side effects on these pieces of code.

Karim Yessad is the only person in our IFS/ARP/LAM community who has a good knowledge of LVERCOR and LRWSDLR options. As of today, pruning or maintenance of these options would be difficult for other staff. If pruning of these options is agreed, Karim advocates for pruning them in 2018 or 2019, but not beyond the end of year 2019.

Pruning could be done within the build of a common cycle, rather than entering a T-cycle first.

Claude stressed that pruning the deep atmosphere code had been discussed in the NWP Section at MF (CNRM/GMAP) and with the Climate group (GMGEC), who all agreed to this proposal.

Action on EC, MF and LAM: contact appropriate teams and scientists active on the dynamics codes, and check whether the deep layer option can be pruned safely from the shared codes.

10. Content and timing of cycles

The timing of CY46 was confirmed for mid-January (EC would send MF CY45R2 for starting the merge on 15 January) with a declaration planned by end of March 2018. The timing of CY46R1 at EC was rather constrained and this build should occur on April-May 2018 in order to leave enough time for pre-operational testing of both science and OOPS-IFS. EC confirmed that CY46R1 was the target cycle for implementing OOPS in operations, and do this before starting preparations for the move of the data centre to Bologna.

For CY47, both EC and MF have still quite a few uncertain milestones in their planning (specific timing of move of data centre and confirm timely progress and operational installation of OOPS at EC, timing of HPC procurements in both EC and MF). These uncertainties were leaving quite a few options of timing very open, to be discussed again in the next meetings.

Regarding the timing of CY47, two scenarios were kept:

i) “Early CY47”:

- a. have a quick CY47 to be built in the autumn 2018, based on CY46R1 from EC and perhaps a “small” or even no CY46T1 from MF (very likely then no science at all in CY46T1, only fixes from previous cycles). This option probably would enable both EC and MF to have a joint cycle including all OOPS-proof codes in C++ and FORTRAN. However, it would mean that cycling activity in 2018 would be fairly high still.

ii) “Late CY47”:

- a. CY47 in first quarter of 2019 or even later (?). OOPS re-factoring aspects not included in CY46 would then be exchanged via a specific CY46_OOPS branch (like for CY45_OOPS). This scenario would leave more time for fixing pending technical problems in various configurations, after the significant code overhaul of the “OOPS cycles” (CY43 through CY46), as well as a possibility to add some science.

There probably still is time left for deciding, and the next update will be made at the 19 March 2018 coordination meeting (Toulouse).

Joint cycle	ECMWF	MF	Start of phasing	Declaration	Misc. / Oper plans

CY43			September 2015	February 2016	Declared 25 Feb.
	CY43R1		March 2016	June 2016	Scientific changes
	CY43R2		May 2016	?	Re-factoring for OOPS
	CY43R3		October 2016	November 2016	Model + DA
		CY43T1	April 2016	June 2016	Including Aladin and Hirlam
		CY43T2	October 2016	mid-November	Wrap-up of bugfixes from [CY40-CY42], as well as MF E-suite changes from CY42_op1/op2
CY44			mid-November 2016	End of February 2017	The build process of this cycle might be in multiple steps to accommodate necessary input for OOPS in IFS. Tbd in forthcoming video-conferences.
	<i>CY44R1</i>				<i>Dropped</i>
		<i>CY44T1</i>		<i>Cancelled in order to build the technical OOPS cycle CY45</i>	<i>Dropped</i>
CY45			March 2017	28 June 2017	MODEL object re-factoring
		CY45T1	2nd October 2017	End of November 2017	Including Aladin and Hirlam
	CY45R1		May 31 st 2017	August 2017	Operational Jan/Feb 2018
	CY45R2		November 2017	December 2017	12h overlapping DA (op. Jul `18) + OOPS up-to-date re-factoring
CY46			Start Jan 15 th , 2018	End of March 2018	
		CY46T1	May-June or Sept-Oct 2018		Timing depending on schedule of CY47 – might only be a bugfix cycle for MF+LAM
	CY46R1		April 2018	May 2018	OOPS target cycle for operations before move to Bologna would occur + science
CY47			Autumn 2018 or in 2019		Early or late scenario. To be

					further discussed.
	CY47R1				New HPC technical (Q2 2020)

11. AOB

Claude will visit ECMWF next week (EWGLAM meeting), and discuss several OOPS aspects with Deborah and Olivier (Friday 6). Daniel will be there as well, which could allow discussing CY45T1 aspects together.

12. Next meetings

Next technical video-conferences:

- ⇒ reminder of Wed 26 September (minutes available from Claude)
- ⇒ Thursday 7 December, 2017 14h30 CET / 1.30pm UK

Next Coordination video conferences:

- ⇒ will be decided at the 19 March meeting in Toulouse

Next physical Coordination Meeting:

- ⇒ Monday 19 March 2018, meeting to take place in Toulouse (full day)

For information: next OOPS Project Board on Wed 15 November, 10h30 CET / 9.30am UK (??)

List of actions

1. Action on both MF (Claude, Ryad, Stéphane) and EC (Deborah, Tomas) to agree on the content of link and runtime information to be included in FLUBs (compilers tested, versions of libraries, extra data files etc.)
2. Claude will check with Gérald/Loïk/Etienne as well as Sébastien, whether they intend to continue discussing the potential issues with the LSPRT option in the assimilation code. This includes exchanges about technical notes describing the bugs found on both sides, and a specific discussion when G/L/E visit Sébastien on 20-22 November. Claude will keep Steve informed
3. Claude to check with Philippe Marguinaud about potential GRIB2 features to enter the ECMWF ecCodes packages, and provide feedback to Deborah and Shahram Najm.
4. Action on Steve and François: François to send details about the GNSS VarBC implementation in CY42_op2. Steve to send information about VarBC with AIREP in CY45R1

5. EC (Steve) to send MF (François) information about the lightning parameterization in CY45R1
6. Action on EC, MF and LAM: contact appropriate teams and scientists active on the dynamics codes, and check whether the deep atmosphere option can be pruned from the shared codes

Appendix 1: content and timing of CY45T1 at MF

CY45T1: Oct-Dec 2017. Deadline for contributions Thursday 28 September, 23:59 CET.

Provisional input:

- System operational aspects (Météo-France o/e-suites):
 - Fixes phased on top of CY45, for enabling to run screening and minimization in Arpège 4D-VAR and Arome 3D-VAR **in CY43T2** (P. Moll, F. Suzat, **C. Payan**, P. Brousseau, E. Arbogast) (**)
 - *Fixes for CANARI in CY43T2, tbc* (**)
 - Phased contributions to MF's Arpège+Surfex e-suite based on CY42_op2 (GMAP staff) (**)
- System technical aspects:
 - PREP with FA file formats, deactivate default use of LFI format (Ph. Marguinaud)
 - FA file format support in FESTAT (R. El Khatib)
 - fixes for LAM+SURFEX and MPI in order to enable MPI tasks running in E-zone regions only (REK)
 - optimizations for Full-POS; important updates for Full-POS in OOPS (configuration 903 for Arpège and Arome, and PostProcessor object in OOPS) (REK)
 - pruning of FEMARS in CNT3/IFS code (REK)
 - drHack: a runtime profiling facility to dynamically generate call tree information for any configuration (F. Suzat)
- Diagnostics and specific post-processing:
 - add surface fields to DDH diagnostics (Y. Seity)
 - Flexible DDH OpenMP debugging (F. Voitus):
 - Introduction of a new DDH type devoted to the DDH budget in APL_AROME
 - Fix for storing and cleaning the DDH structure when KSTEP=0
- Arpège and Arome model dynamics:
 - first codes for implementing the Quasi-Elastic NH equations in global and LAM (for finite differences at least) (K. Yessad, F. Voitus)
 - vertically variable SITRA in SI operator (K. Yessad)
 - more flexible filtering of orography for PGD files (KY)
 - simplifications in the code of LASCAN when interpolating half-level fields (KY)
 - if ready: enable to only switch on higher-order interpolations in the last iteration of P/C scheme (could be numerically cost-effective when LPC_FULL, KY)
- Arome physics:
 - add a term of deposition for the microphysics (Y. Seity)
 - a significant rewrite of the ICE3 microphysics code in order to reduce the dependency upon the time step value (Note: some bugs fixed while rewriting) (S. Riette)
 - recent updates for computing gust winds, from the CY42 e-suite (enable to compute gust winds over a different time range than the forecast range of the output file) (Y. Seity)
 - *implement SURFEX V8.1 ? Tbc* (Y. Seity)
 - first version of the LIMA two-moment microphysics scheme (Y. Seity, B. Vié)
- Assimilation methods:
 - updates for Ensemble Data Assimilation (EDA) and for using grid point σ 's in AROME. This contribution includes a significant rewrite of LSPFCE=.FALSE. for LAM, *which will change its functioning* (Y. Michel)
 - enable to diagnose the content of one column of B; enable NETCDF I/O of LAM stabal and stabcv files for the B-Matrix (Y. Michel)

- optimization of code for filtering B matrix structures and for computing the inflation factor for AROME EDA (previous codes already in CY43T1) (Y. Michel)
- Observations:
 - enable monitoring of data from the MTVZAGY microwave radiometer on board METEOR (Russia) (Ph. Chambon, F. Suzat)
 - enable monitoring, possibly assimilation, of data from the AMSR2 microwave radiometer on board GCOM-W1 (Japan) (P. Chambon, F. Suzat)
 - implement monthly varying versions of microwave surface emission atlases (F. Suzat)
 - monitoring and potential use of scatterometer winds from the Indian satellite ScatSat-1 (tbc, C. Payan in coordination with ECMWF/G. De Chiara)
- ALADIN:
 - fix for quadratic/cubic coupling (Jan, following Jozef and Alexandre)
 - fixes for ALARO-1 (Jan Masek)
 - combination of SURFEX with TOUCANS (D. Degrauwe and R. Hamdi)
 - *prognostic graupel scheme "LGRAPRO" (B. Bochenek) tbc*
 - phasing of VFE work for NH dynamics (Petra Smolikova)
 - note: a fix for writing out spectral orography in e923 clim files was added as well, already in CY45_main (originally fix by F. Taillefer)
- HIRLAM: final list is under discussion
 - observation pre-treatment aspects, Bator/Oulan (mostly E. Whelan)
 - microphysics and radiation ()
 - Surfex changes
 - assimilation code (M. Lindskog, others) – Jb, Jk, ... -
 - miscellaneous cleaning and fixing (U. Andrae)
- OOPS re-factoring:
 - further reorganization, encapsulation and passing-by-arguments of the LBC code for LAMs (H. Dhouioui, A. Mary, K. Yessad, B. Bochenek)
 - more generally, finalize the adaptation of Arpège options to the re-factored observation operator codes of phase 2: APACHE, ACHMTTL/AD (MF/ OBS team)

Expected timing for declaring CY45T1 in MF's GIT repository is in December 2017.

Note: some of the OOPS re-factoring items will be managed as a specific OOPS branch on top of CY45 first (but might enter in parallel in CY45R1, R2 or T1 depending on EC or MF possibilities).

(**) in parallel to the build of CY45T1, a significant update of the base version of CY43T2 (CY43T2_main) was started including a complete wrap-up of the e-suite changes from CY42_op2 and the fixes for running data assimilation configurations. *As of end of September 2017*, the state-of-art of this **CY43T2_bf** was an update of CY42_op2 by about 80%, as well as fixes implemented enabling to run single steps of screening and minimization of both Arpège 4D-VAR and Arome 3D-VAR.