

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, Daan Degrauwe

To: (HIRLAM) Daniel Santos-Muñoz

File: RD18-xxx

Subject: Draft minutes of the IFS/Arpège coordination meeting of 21 June 2018.

Participants:

Meeting room (Toulouse): CNRM Videoconf room R. Durbe.

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

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

ALADIN: excused

HIRLAM: Daniel Santos-Muñoz

1. Adoption of Agenda

adopted

2. Approval of Minutes of meeting of 19 March 2018

approved

3. Review of list of actions from last meeting

1. MF and EC: continue investigate the codes for LSPRT=.T. and exchange information on any further testing or code fixing. => *MF is addressing several bugs in the Arpège 4D-VAR when LSPRT is TRUE (it was switched to FALSE in a recent e-suite, pending to corrections of the various problems). MF will update a technical note about these problems in the summer. EC informed that they have stopped investigations for the IFS, and they would be interested to see the content of the work done at MF. Action open.*

2. MF (contact: Patrick Moll) and EC (contact: Lars Isaksen) to exchange detailed information about how GNSS data are being assimilated. => *no exchange yet. Lars can contact Patrick at any suitable time. It is assumed that the level of information should encompass several aspects of the GNSS data assimilation (VarBC predictors, pre-treatment and choices of analysis stations etc.). Action open.*
3. Questions for EC (Steve):
 - a. MF asked EC about their future plans for SST, whether daily MERCATOR products for instance would be considered (HRES and ENS). => *Steve will provide MF the slides of a talk given recently at the coupled DA workshop held at CERFACS. Action open.*
 - b. MF asked about how EC were handling the drift information of dropsondes, whether this was handled the same way as for RS. => *Steve explained that the intention at EC was to indeed enable the assimilation of BUFR formatted data along the same definitions as for RS data. He will check for the details of progress and plans with Bruce Ingleby and send information to MF. Action open.*
 - c. Which component of the HRES/ENS systems have been optimized for Open-MP in CY45R1 ? => *the Open-MP optimization was on parts of the wave and ocean models. Deborah stressed that an important optimization was gained by adapting the IO server developed by MF (P. Marguinaud) for the ocean component. Action closed.*
4. EC and MF to exchange information about strategy for testing ENS and EDA systems. MF to provide any comment about M. Leutbecher's note (strategies for early testing and evaluating changes in the ensemble systems). => *Martin's paper, that is to appear soon in QJ, has been sent to the MF Arpège and Arome EPS teams. In the paper, Martin suggests a methodology for using smaller size (than operational) ensembles for evaluating R&D changes at a lower computational cost. A key aspect is to use fair scores, and to have interchangeable members. Claude explained that such approach would not be evaluated at MF in the short term, however one area of work was to implement more SPPT and SPP ingredients in PEARP, and reduce the level of multi-physics in the global ensemble. If successful, this evolution would increase the interchangeability of PEARP members. Another important aspect was to evaluate the use of single-precision, which MF already started to assess in the Arome EPS, with a significant computational gain (about 30% of the total cost). EC agreed, and they intend to apply single-precision in all forecasts of their HRES/ENS system (which is what they prepared for their HPC2020 benchmark). Steve stressed that EC are preparing an overview paper about the cost (and potential areas of cost reduction) of the ensemble systems in general (in particular also EDA). The note is intended to be presented at the next SAC meeting. Steve will send a draft version to MF (action on Steve). Action closed.*

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

François recalled the main operational NWP versions in MF (Arpège 4D-VAR, Arome-France 3D-VAR, their EDA and EPS versions). The very next e-suite scheduled for operational use is the Arome-France ensemble data assimilation (aka AEARO) which is based on CY42_op3. The Arome EDA will provide the initial condition perturbations to the Arome-France EPS (PEARO). In addition, a new clustering method is being used for selecting the Arpège EPS members (PEARP) for the lateral boundary condition data of AEARO and PEARO.

The summer-autumn 2018 e-suite will then be based on CY43T2, with major changes in the horizontal resolution of the global systems (about 5km over France for Arpège trajectory and production forecasts, 4D-VAR inner loops at 90km, resp. 40km, about 7.5km for PEARP). The Arpège EDA (AEARP) will have an increased number of members (50 instead of 25). The other scientific changes include:

- Tuning in the dynamics (horizontal diffusion, SL iterations number)
- Tuning of convection scheme in ARPEGE
- Improved version of AROME microphysics scheme (to be confirmed)
- Tuning of sigma_b for humidity in ARPEGE-EDA
- Use of T2m and H2m over nature tail in surface analysis
- Variational bias correction for GNSS observations
- Assimilation of more IASI channels over land
- Assimilation of wind from ScatSat-1 (Ku band)
- Assimilation of AMVs from GOES-R (16)
- Monitoring of GNSS-RO on FY-3C
- Monitoring of AMSR-2 from GCOM-W1 (7 channels)
- Monitoring of ATOVS, ATMS, MWHS-2 DBNet data
- Monitoring of Doppler winds and radar reflectivity (European radars)
- Initialization of CMO-1D in AROME-Overseas with Mercator 4x per day
- News diagnostics: visibility, type of precipitations, ...

In 2019, it is planned to port CY46 or CY46T1 to e-suite, with a preliminary set of scientific changes : ECRAD, new convection scheme, new schemes used in SURFEX (1D sea-ice model, 1D ocean mixing layer model, 1D lake model, town model), snow analysis, European radar assimilation (Arome), Mode-S wind (Arome), GNSS-RO (ROSA/MT, GNOS/FY-3C), Metop-C, NOAA-20 etc.

The longer term planning includes a potential technical e-suite based on CY47 or CY47T1. The horizon for planning is then constrained by the timing of migration to the new HPC, whose switch to Operations is foreseen between August 2020 and March 2021.

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

Steve noted that Cycle 45r1 became operational on 5 June 2018. He then went on to present plans for Cycle 46r1. The timescale is to declare 46r1 in October 2018 and implementation in June 2019. This may be the last scientific cycle before the HPC move to Bologna and so has twin goals of being as safe as possible (to minimise fixes or emergency changes during the HPC move period) whilst also delivering the largest possible improvement (as its likely ECMWF will go over two years without a scientific cycle implementation). Key themes include the introduction of continuous data assimilation (see 9.2 below), 1 hour radiation in the ensemble system, a number of physics changes, including wave physics which has a particularly notable impact on wave scores, as well as convection changes. Observation changes include extension of use of correlated observation errors, RTTOV12.2, extension of slant path radiative transfer to geostationary radiances, and some improvements to MW imager assimilation. The EDA will be increased from 25 to 50 members, but

at neutral cost, due to compensating changes (e.g. temporary reversion to OI land surface DA in EDA members). The land surface DA in the HRES will be enhanced using EDA Jacobians, a major cost saving, and the introduction of SMOS neutral network soil moisture.

6. Look back on CY46 and earlier cycles (Claude)

Claude briefly explained that validation of the (mostly Arpège and Arome assimilation) bugfix branch of CY43T2 was now close to completion for all operational configurations, providing an acceptable basis for building the e-suite HR version of Arpège as presented in François' slides. This is for the time being a version CY43T2_bf.08 in the MF GIT repository. A few extra fixes should be added, and a first operational+technical version of CY43T2_bf would be built soon (CY43T2_op1).

CY43T2_bf.08 would probably also become the base version for dissemination in Aladin partner countries (so-called "export version"), and actually several members already are testing it locally (Hirlam group, Czech Rep., Belgium, Slovakia, soon Algeria). A decision whether to first build a bf version 09 with additional fixes will be taken in coordination with the LAM partners.

MF had started to evaluate and fix the Arpège and Arome assimilation, at first very technically in CY45T1, and now debugging in CY46 has started. As of today, an important bugfix branch is being ported from CY43T2 to CY45T1 and eventually to CY46. The expectation is that this debug branch can enter CY46T1 as one major code contribution this autumn. The draft list of contributions for CY46T1 is provided in Appendix 1.

CY46 code also is being assessed in specific OOPS trials at MF (E. Arbogast).

7. HIRLAM comments

Daniel pointed out that HIRLAM will be affected by the HPC migration to the new computer and data centre in Bologna, as they have a LAM Reference System running on the ECMWF computer.

8. ALADIN comments

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9. Specific issues:

9.1. OOPS Progress (mostly EC)

OOPS-IFS tests are steadily progressing. A detailed report was given at the last technical video-conference (7 June). Items like VarBC, VarQC, TOVSCV (except for cloud part which will no longer be used) are now functional. A restart facility also is working, enabling to relaunch the traj+minim from the start of any outer loop within the OOPS executable file. Results of 4D-VAR in low truncation tests are satisfactory, and now validation of operational-type of truncations is in progress (Tco399 and Tco1279).

Specific aspects that are being checked now encompass the reproducibility of the 2nd-level optimization of the minimization (at present, the OOPS-IFS and IFS solutions of preconditioning vectors for the inner loops $k \geq 2$ are not equivalent due to one re-orthogonalization step). Optimization of the OOPS-IFS configuration is also actively looked at. The full OOPS-IFS 4D-VAR requires about 3000s wall clock, to be compared with about 2500s for the IFS 4D-VAR. However, the difference includes one trajectory step (the initial one) which is accounted for in OOPS and not in the classical IFS. Optimization of the interpolation of trajectories is going to be studied soon. Memory consumption is increased in OOPS, but the increase remains within tolerable bounds for Operations on the CRAY.

Among the few missing items in OOPS-IFS/CY46, some might not be ready before CY46R1 is being declared: weak constraint Jb, Jc-DFI, screening (work in progress). A very detailed validation using the TL/AD tests is also being done now (Lars Isaksen makes careful checks of Jo-tables and obs adjoint test results in OOPS).

Olivier will send the CY46 branch with all OOPS changes that will be included in CY46R1 to MF by the end of June.

9.2. Update on continuous data assimilation for CY46R1 and its implementation in OOPS (Peter)

Peter presented the recent progress with developing the continuous data assimilation (CDA) in the IFS. EC plan to port CDA to e-suite with CY46R1. This implementation will enable to extend the assimilation window of the early delivery system, as well as to shift the cut-off time of observations in each outer loop, so that new observations can be added to the (new) ECMA and be screened. To achieve this, screening will be called at each outer loop as well, so that all “traj” tasks will become “re-screening” tasks. An additional benefit is that very early observations can be screened earlier than today. For now, the tests will include four outer loops, but there could be more in principle (five etc.).

MF commented whether this CDA version would enable to change the activation flag of earlier observations, in the typical case where earlier observations might have been rejected in an outer loop N-1 (for instance due to a too large departure value) and then become accepted if confirmed by new observations in an outer loop N. EC confirmed that such re-activation is made possible.

In parallel, EC are working now on making the screening code compatible with OOPS. This requires some code changes for handling the interfaces to the ECMA files, the obs set definitions etc.

Peter explained that COPE was scheduled for operations only after the move to Bologna. COPE would bring another level of simplification and flexibility into CDA, since the observation pre-processing then is made totally on-the-fly. With the present pre-processing code, a 4 outer loop CDA mechanism requires to handle some hard coded scripting where four loops are explicitly stated. This is not very effective from the operational and maintenance point of view.

10. Content and timing of cycles

Below is an updated version of the overview Table of Cycles, after discussion. It was stressed at the 19 March meeting that after CY47 most of the planning and the schedule still had many “?”. One reason for the uncertainties is the yet-to-be-confirmed calendar of HPC operations both in MF (switch of operations to new HPC planned between August 2020 and March 2021) and at EC (confirm dates of the move to Bologna+new HPC).

It was stressed that there was a potential risk to have two follow-up joint cycles separated by significantly more than 1 year (CY47 – CY48). The recommendation in the meeting was not to allow more than one year delay between joint cycles.

Joint cycle	ECMWF	MF	Start of phasing	Declaration	Misc. / Oper plans
CY45			March 2017	28 June 2017	MODEL object re-factoring
		CY45T1	2nd October 2017	24 January 2018	Including Aladin and Hirlam
	CY45R1		May 31 st 2017	August 2017	Operational June 2018
	CY45R2		Mar 31 st 2018	Technical cycle for introduction of ecBuild	
CY46			Start Jan 15 th , 2018	10 April 2018	<i>OOPS aspects added as extra branch on CY45R1 for CY46</i>
		CY46T1	Oct-Dec 2018		Technical update for fixes (assimilation) plus some science
	CY46R1		31 May 2018	October 2018	OOPS updates + science
	CY46R2			Until end of 2018	Research section version only if CY46R1 is frozen for operations before Bologna
CY47			Mid-January 2019	End of March 2019	Target joint cycle for baseline OOPS in Research mode
		CY47T1	Spring or autumn 2019		Could contain OOPS fixes for Arpège and Arome
	CY47R1			2 nd half of 2020 (after move to Bologna) ??	
CY48				Q2 2020 ??	

11. AOB

Claude asked EC whether they had any plans to investigate single precision aspects in parts of the data assimilation codes. EC said that very preliminary discussions had taken place for the TL/AD models, but it is likely that single precision eventually won't be addressed (there is a risk that the incremental add-up of adjoint contributions rapidly would become too much inaccurate).

Claude further asked EC whether they had any specific front or cache file data base, for instance for enabling a quick access to recent model data when computing scores or diagnostics. EC explained that the cache functionality exists indeed and is totally embedded within the MARS interface and access system. So MARS is actually fully handling the data storage and retrieval for the HPC users.

Note: slides from the talks by François, Steve and Peter can be obtained from Claude upon request.

12. Next meetings

Next technical video-conferences:

- ⇒ reminder of Thu 7 June (minutes available from Claude)
- ⇒ Tuesday 16 October, 14h30 CET / 1.30pm UK

Next Coordination video conferences:

- ⇒ Thursday 20 September, 2018 14h30 CET / 1.30pm UK

Next physical Coordination Meeting:

- ⇒ March 2019, meeting to take place in Reading (full day). Precise date tbc in upcoming coordination video conferences.

List of actions decided:

1. MF and EC: continue investigate the codes for LSPRT=.T. and exchange information on any further testing or code fixing.
2. MF (contact: Patrick Moll) and EC (contact: Lars Isaksen) to exchange detailed information about how GNSS data are being assimilated.
3. Questions for EC (Steve):
 - a. EC will send MF the slides of the talk given at the coupled DA workshop in June.
 - b. MF asked about how EC were handling the drift information of dropsondes, whether this was handled the same way as for RS. Steve to check with Bruce Ingleby.

4. EC are preparing an overview paper about the cost (and potential areas of cost reduction) of the ensemble systems in general (in particular also EDA). The note is intended to be presented at the next SAC meeting. Steve will send a draft version to MF.

Appendix 1: provisional content of CY46T1 at MF

CY46T1: this cycle ideally should include all updated fixes enabling to run Arpège and LAM data assimilation systems [phasing up from CY43T2 – would include CANARI revival] + updates for Arpège-Surfex_v8 (adapted from CY42_op2 via CY43T2_bf) + any other fixes collected within [CY43-CY46].

Some additional new science would be allowed too.

Timing: Oct-Dec 2018. The deadline for contributions is Friday 28 September. Declaration to occur before X-mas.

Provisional content:

- System operational aspects (Météo-France o/e-suites):
 - adapted fixes for Arpège+Surfex_v8 (from testing CY43T2_bf and comparison with CY42_op2) [*all contributors to CY43T2_bf.04-08*]
 - adapted updates from CY42_op3 suite (i.e. for AEARO) [Yann Michel]
 - any fix needed to run Arpège 4D-VAR or LAM 3D-VAR as tested in CY43T2_bf, and possible extra re-phasing with respect to CY45-CY46 [Florian, Camille, Thibaut, Dominique R., Etienne etc.]
 - re-phased fixes and recoding necessary to revive CANARI (included in previous item)
- System technical aspects:
 - reminder: GRIB2 facility enabled using ecCodes software (mandatory for compiling CY46)
 - enable saving SURFEX surface fields states at each step of a model integration, in order to enable a reinitialization of SURFEX for a restart (P. Marguinaud)
 - remove Fortran version of LFI routines and keep only C code version (P. Marguinaud)
 - implement an LBC file re-reading mechanism (P. Marguinaud)
- Full-POS software:
 - several fixes or minor developments (R. El Khatib)
 - new diagnostic fields (see list in the Aladin partners' bullet below)
- Diagnostics and specific post-processing:
 - harmonize the names of fluxes and tendencies (3D and 2D) in ARPEGE and AROME (flexible DDH, F. Voitus),
 - finish the implementation of DDH terms from the dynamics (flexible DDH, F. Voitus)
 - *visibility; precipitation types; various flavours of snow cover height (I. Etchevers)*
 - *for aeronautics: pressure and flight level height of Tropopause and jet; convective cloud top and bottom pressure (O. Jaron)*
- Arpège and Arome model dynamics:
 - various dynamics updates and cleaning by Karim (K. Yessad & F. Voitus):
 - several fixes for the treatment of the NL Laplacian term in NH-QE (note: the NH-QE version coded in CY46 is unstable)
 - alternative, simpler version of the SI term coded for NH-EE
 - the possibility to define the vertical divergence using moist R instead of dry R (note: the default choice in the code will not be changed though)
 - the possibility to control the increase of horizontal spectral diffusion by passing a ratio by namelist (in NAMDYN), rather than the resolution-depending parameter NSREFDH
- Arpège atmospheric physics:
 - tunings and code adaptations needed for Arpège new resolution T11798C2.2L105
 - evolution of Lopez microphysics (Y. Bouteloup)
 - interface to the IFS deep convection scheme (Y. Bouteloup)
 - interface to the ECRAD radiation scheme (Y. Bouteloup)
 - computation of the TKE production term from deep convection (Y. Bouteloup)
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 - *first rewrites of PCMT code (J.-M. Piriou, Y. Bouteloup)*
 - *review stability functions for PBL with respect to consistency of energy cycle, potential impact of Lewis number # 1 (P. Marquet)*

- *TL linear physics for 4D-VAR: updates in microphysics (C. Loo)*
 - *other Arpège physics changes ??*
- Arome atmospheric physics:
 - interface to the ECRAD radiation scheme (Y. Bouteloup)
 - *diagnose visibility for post-processing and end-user applications (O. Jaron, Y. Bouteloup, I. Etchevers)*
 - *other Arome physics changes ??*
- SURFEX based on v08 in [CY43-CY46T1] **or implementation of Surfex v8.1+** depending on results of testing in Arome (Y. Seity):
 - bf for TEB when garden not activated (wrong calculations of vertical/horizontal fractions)
 - bf for 1D-ocean mixing layer model CMO (used in AROME-Overseas)
 - in parallel, GMAP will re-phase all recent MF NWP changes required for Arpège and Arome-France (from CY43T2) on top of Surfex V8.1, in the context of the build process of V9 of Surfex at GMME (Y. Seity, S. Faroux). These changes include ORORAD, single precision, Arpège assimilation etc.
 - linked with the previous bullet, a trial will be made for implementing V8.1 (with the help of S. Faroux)
- Assimilation methods:
 - improvements on EDA for AROME (reporting from CY43T2_op1), use of EDA information in AROME-France 3D-VAR (Y. Michel, P. Brousseau, L. Berre, B. Ménétrier)
 - technical developments preparing LAM EnVar, including adjoint tests (Y. Michel)
- Observations:
 - AMDAR humidity data: optimize QC and assimilation in ALARO or AROME 3D-VAR (P. Moll, A. Trojakova, F. Meier)
 - first codes for assimilating all-sky radiances using a Bayesian inversion method (P. Chambon)
 - new satellites/instruments: 1) Aeolus L2 HLOS winds, 2) MTG-IRS, 3) IASI-NG, 4) winds from various scatterometers (GMAP/OBS)
 - adapt codes for assimilating European radar data from OPERA (E. Wattrelot)
 - preparations for assimilating radar dual-polarisation data (E. Wattrelot)
 - use of infrared emissivity atlases for the use of IASI skin temperature retrievals (V. Guidard)
 - *first potential code adaptation of IFS/Arpège/LAM codes in order to test COPE3 pre-processing tools (E. Wattrelot, M. Dahlbom) tbc*
- ALADIN:
 - transfer of ALARO-1 fixes that entered CY43T2_bf.08 (J. Masek) – note: those fixes that entered CY43T2_bf.04 already are in CY45T1
 - fix for CAPE computation starting from most unstable level – make the computation independent of number of processor (R. Brozkova)
 - improvements in ACRANE2 (J. Masek): optimized version enabling cheap diagnostics of clear sky fluxes and reducing memory needed for LW intermittent storage. Possibly, there can be further improvements in calculation of direct solar flux.
 - new fields in Fullpos (CHMI & J. Cedilnik): convective temperature, mean radiant temperature (needed for evaluating thermal comfort), global normal irradiance (for energy producers), more fields according to outcome of J. Cedilnik's stay at CHMI (August 2018)
 - some CANARI fixes (A. Trojakova)
 - *dynamics changes (P. Smolikova) ?*
 - *Graupel code: requires a deeper restructuring (out of range for CY46T1). In the meanwhile, (IF LGRAPRO) statements need to be commented out in four subroutines in order to compile with Intel.*
- HIRLAM (in discussion between D. Santos and C. Fischer):
 - Harmonie-Arome related physics, especially microphysics changes (and interface to radiation)

- dynamics (one change in gnhd3.F90 originally from M. Hortal)
- Bator and obs pre-processing (reviewed with F. Guillaume and E. Whelan)
- assimilation: 4D-VAR/LAM and Jc-DFI fixes, *MSGinit* ???
- system aspects (fixes and portability)
- surface perturbation for EPS in pertsfc.F90
- fixes required for Harmonie-Arome, re-phased from CY43T2_bf[04-08] or from CY43H2 into CY46
- OOPS re-factoring:
 - "Finalize Fullpos adaptations for OOPS" (R. El Khatib)
 - Adaptations of ARPEGE forecast + Fullpos in-line for OOPS (R. El Khatib & E. Arbogast)
 -
 - *adaptation of LAM MODEL components, possibly DDH code, to OOPS (A. Mary)*
 - *remove the Tomas' trick for YOMPHY* variables. Proper handling of the MODEL parameters inside calls to MF obs operators (A. Mary & OBS team ?)*
 -