

# 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) Ulf Andræ

**File:** RD15-xxx

**Subject:** Minutes of the IFS/Arpège coordination meeting – in view of Cycle 42 - held by video-conference on 12 March 2015.

**Participants: to be confirmed**

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

**ECMWF:** Steve English, Deborah Salmond, Peter Lean, Sylvie Malardel

**ALADIN:** Piet Termonia

**HIRLAM:** Ulf Andrae

## 1. Adoption of Agenda

The agenda was adopted.

## 2. Approval of Minutes of meeting of 13 November 2014

Approved.

## 3. Review of list of actions from last meeting

1. *Update the recommendations about Fortran/C++/Boost standards for benchmarking and call for tender specifications => Deborah and Claude. => for FORTRAN, F90 is mandatory, but support for F2003 is highly recommended on any new HPC for IFS-Arpège-LAM partners. For C++ and Boost, Claude to liaise with Yannick. (action)*
2. *Deborah to check with Yannick where/how OOPS design aspects can be discussed among EC/MF/LAM partners (technical video-conferences like for re-factoring ?). => a first technical videoconference about the observation operator codes was held on 11 March (see summary below). Yannick Trémolet is now project manager for the OOPS Project, and he will arrange the OOPS technical videoconferences as well as coordinate the progress and plans. Claude is member of the OOPS Board, where he represents both MF and the LAM partners for managerial issues. This action closed. A regular cross-exchange of information and possibly coordination decisions should be ensured between the OOPS Project per se, and the IFS-Arpège-LAM code collaboration. It was suggested that this aspect could be discussed at one of the forthcoming OOPS Board meetings. Action on Claude and Deborah.*
3. *Peter, to send information and/or ODB code about his optimizations to ODB contacts (Dominique, Eoin, Alena). Done, the note was further distributed to specific LAM contacts in teams where Aladin/Arome data assimilation is being run, and to GMAP staff. Action closed.*

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

- [July 2014 / CY38T1\\_op3](#) : Introduction of I/O server in operational scripts (technical modifications to prepare resolutions upgrades for Arome & Arpege)
- [April 2015 / CY40\\_op2](#) : New resolutions and other changes =>
  - Arpege TL1198c2.2L105 (7.5km over W Europe); 4D-VAR TL149c1.0L105 & TL399c1.0L105); 4 forecasts per day up to 102h;
  - AEARP TL479c1.0L105 (25 members);
  - PEARP TL798c2.4L90 (10km over W Europe, 36 members) run twice a day up to 108h;
  - Arome 1.3kmL90;
  - Aladin-Overseas 7.5kmL70
- June-Dec 2015 : [Arome nowcasting](#) system pre-operational (new system)
- Sept 2015 : [Arome overseas](#) (new systems)

- June-Dec 2015 : NWP e-suite based on [CY41T1](#)
- Dec 2015 -Feb 2016 : Only one “Phase 1” cluster available (C1)
- Feb-June 2016 : Migration of operational suite to C4
- June-Dec 2016 : [Arome EPS](#) system pre-operational (new system)
- July-Aug 2016 : Only one cluster “Phase 2” available (C4)

Further changes in the Arpege CY40\_op2 e-suite:

- New resolutions for Arpege (deterministic, EDA, EPS) and Arome (deterministic)
- 30' time-slots in Arpege 4D-Var
- Increase of radiances density as input data in screening
- Assimilation of sounding channels (temperature and humidity) for clear sky pixels over sea,
- sea-ice and land for DMSP-F17 and F18
- Use of edge swath ATMS data
- Assimilation of 6 sounding channels of SAPHIR
- GPSRO (vertical extension, reduced sigmaO)
- New CrIS tropospheric channels (+22 over sea, +8 over land)
- Assimilation of EARS ASCAT Metop-B
- CSR of Meteosat-7 and Mtsat-2
- New white liste of GPS ground observation (adaptation to new orography)
- TEMP BUFR
- “Jc\_dfi”

Further changes in the Arome CY40\_op2 e-suite:

- From 3h to 1h assimilation cycle (more observations assimilated: radar, ground GPS, SYNOP, SEVIRI)
- Incremental Analysis Update (IAU) used to keep 0, 3, 6, 9h, etc. production time bases
- Predictor-corrector scheme
- Modified semi-lagrangian advection scheme “COMAD”

- Changes in the physics (autoconversion, orographic surface drag, ...)
- Numerical diffusion tunings (spectral and grid-point)
- TEMP BUFR

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

**Cycle 41r1:** to be implemented in April 2015

**Interim cycle** (would be 41r2):

- Contents: science upgrades, efficiency gains (TF report: opt\_V1 + I/O server)
- Submission deadline for tested branches from sections: 16 February
- Start RD suite: April 2015
- Hand-over to FD and implementation: optional

**Common cycle with Météo-France** (will be 42):

- Contents: interim cycle, Météo-France modifications
- Merge and testing: June-July 2015

**Priority cycle** (would be 41r3 or 42r1):

- Contents: resolution upgrade, more efficiency gains, other science upgrades, Common cycle as basis (Interim cycle as fall-back)
- Start RD e-suite: July 2015
- Hand-over RD2FD: September-October 2015
- Parallel dissemination: November-December 2015 or November 2015 – January 2016, to be negotiated with Member States
- Implementation: December 2015 or January 2016

Note: Interim cycle becomes implemented (as 41r2) if significant deviation from this schedule occurs

Some highlights in CY41r1:

- Revised semi-Lagrangian extrapolation reducing stratospheric noise
- New surface climate fields (land-sea mask, sub-grid orography)
- New CO<sub>2</sub>/O<sub>3</sub>/CH<sub>4</sub> climatologies from latest MACC-II reanalysis produced at ECMWF

- Activation of lake model (FLAKE)
- Cloud scheme change of rain evaporation, auto-conversion/accretion, riming, precipitation fraction
- Improved representation of supercooled "freezing" rain
- Modified convective detrainment
- Upgrade of inner loop resolutions of 4D-Var to TL255 for each of the three iterations of the outer loops
- Reduction of number of iterations in 1st inner loop and use of full linear physics package
- Changed calculation of background error covariances from using EDA samples of perturbations from last cycle (1/3) and climatology (2/3)
- Active use of SSMIS moisture sounding channels over land and sea-ice, surface-sensitive ATMS channels over land, ASCAT in soil moisture analysis, Altika and Cryosat altimeter wave height data
- Assimilation of GPS-RO with two-dimensional observation operator.
- Twice weekly 11-member re-forecasts

Interim cycle (would be 41r2):

- EDA resolution configuration changes (Resolution TL639 forecast/outer loop, TL191/TL191inner loops)
- Assimilation of aircraft humidity
- Increased use of BUFR TEMP, SYNOP and drifter data (BUFR gradually replacing alphanumeric)
- Technical infrastructure to enable operational assimilation of SMOS data (passive).
- Scene dependent observation errors for AMSU-A
- All sky ATMS, SSMIS F18
- Improved "cold air outbreak" and aerosol screening
- Physics changes (freezing rain diagnostic, radiation LW/SW fluxes...)

- Increase 3 to 5 iterations for SL departure points
- Changes preparing for high resolution

Priority cycle (41r3 or 42r1):

- Final changes for octahedral grid
- Presentation by Sylvie (8.1)

Action: Steve to send MF material in preparation by Elias Holm, about the impact of the changes in the EDA on the performances of the CY41r2 IFS E-suite.

## **6. HIRLAM comments**

Ulf mentioned that Hirlam was preparing CY40H1, based on CY40T1, for an official operational release in the autumn, including the mesoscale HarmonEPS system. Hirlam's next main target cycle would then be based on CY42, i.e. skipping CY41. Tests of the common codes on MICs were continued by Enda O'Brien (Ireland), with contacts with ECMWF (Tomas Wilhelmsson).

## **7. ALADIN comments**

The main version presently being installed in a number of centers is based on CY38T1. An official export version based on CY40T1 will be released hopefully end of April. Piet mentioned that the issue of more Fortran 2003 in future cycles would be discussed at the next Aladin Local Team Manager (LTM) meeting (15 April, Elsinore, Denmark).

## **8. Specific issue:**

### **8.1. feedback by EC about high resolution testing and cubic grid approach (Sylvie)**

Sylvie introduced work at EC in order to implement the cubic grid solution for the next main operational version of the IFS system. The new solution consists of defining an octahedral grid, which is an alternative reduced Gaussian grid on the sphere (as compared to the classical reduced grid used in IFS and Arpège). The octahedral grid amounts to adding 4 extra points of longitude at each new row of latitude when moving from Pole towards Equator, except near the Poles where the usual reduction of points is kept (for CFL stability). While this calculation holds for any type of gridpoint truncation, i.e. linear, quadratic or cubic grids (for a given spectral truncation T), EC investigate the octahedral grid in association with the cubic grid option. Among the technical impacts, there is a 30% decrease in the total number of gridpoints and an observed mean decrease of about 20% in computational cost, compared with the classical cubic grid. The octahedral calculation for a reduced Gaussian grid requires the use of FFTW, even for quadratic and linear grids since these transforms allow that some values of NRGR1 may not write  $2^{**p} 3^{**q} 5^{**r}$  (a factorization constraint that is removed with FFTW).

For the present testing, the surface pressure dealiasing scheme can be totally switched off, and the horizontal numerical diffusion is very much reduced (almost none). The filtering of gridpoint orography also can be reduced when preparing the input climatological data. Scores indicate that the octahedral cubic grid solution is not creating any deterioration of performances, except for a temperature bias at 50 hPa around the Himalaya mountain range. This specific aspect is now being investigated in more detail. The goal is to enable this solution to be ready for the next high resolution increase of IFS, planned for beginning of 2016, with a target horizontal resolution of TCo1279 (i.e. a cubic grid with spectral truncation 1279 using the octahedral grid solution). Furthermore, tests in the Ensemble Data Assimilation system had started very recently.

Action: Sylvie to send participants the slides of her presentation. Claude to disseminate in GMAP.

### **8.2. feedback from the 11 March videoconf about refactoring the obs operators (Claude)**

In the videoconference of 11 March, the overall tasks for the observation operator refactoring were listed: control vector aspects, horizontal interpolations, vertical observation operator part, VarBC, VarQC, Huber norm, Obs error covariance code, ODB. First figures of manpower were proposed by EC, MF and Hirlam.

On the technical side, it was agreed that code exchanges should occur on the basis of CY42. Once refactored, and OOPS-compliant tests approved, the Fortran codes would be re-implemented in a common IFS-Arpège cycle. The first target cycle for IFS-Arpège could then be CY43.

Further technical videoconferences will be organized, in order to start discussing the specific technical specs (interfaces, tests) and the concrete work with the code. A mini-workshop was being considered for the summer 2015, with most of the participants together for a complete wrap-up. For some aspects, work will start soon or asap at EC (horizontal interpolations, ODB, ...) but many tasks will only begin in the autumn, when more manpower is becoming available (MF).

Deborah asked whether the refactoring of SUOBS had been addressed, and stressed that this part of the obs code would be a difficult issue, which should be carefully evaluated by the involved people in the upcoming discussions.

### **8.3. ODB optimisation (Peter)**

Peter summarized his work on optimization, which also is described in his technical note (available by Peter):

- improvements to IOASSIGN (note: this makes the option 4 of IOASSIGN particularly attractive now for most implementation of ODB and IFS/Arpège data assimilation)

- improved parallelism of I/O
- optimizations in scripts
- reduced file sizes by removing the poolmask table

#### 8.4. early feedback by MF about the code of pre-cycle 41R2, in view of building CY42 (Karim, Deborah)

Code exchanges for building CY42 already had started (Deborah, Karim, Stéphane). MF had already tested the compilation of a pre-CY41R2 on their BULL cluster, and sent feedback for changes to EC. Karim had started to check the code and wrote a first note about the expected phasing difficulties (including some LAM aspects). Deborah stressed that CY41R2 was expected to be completed on week 16-20 March, and to be sent to MF on 24 or 25 March. MF would start the actual merge between CY41T1 and CY41R2 at the very beginning of April.

Claude stressed that during the technical coordination of CY42, the issue of whether the FIELDSETs (GMVs, GFLs) should be passed by arguments (for later OOPS compliancy) had to be evaluated (target date was the next IFS-Arpège technical videoconference on 23 April). A prerequisite was that the passing-by-arguments could be implemented and tested via a Python script which is being developed by Olivier Marsden (EC). Deborah will check with Olivier whether this script can be ready in time, and tests could start asap. (Action)

### 9. Content and timing of cycles

Joint cycle	ECMWF	MF	Start pre-φ	Declaration	Misc. / Oper plans
CY41			End of March 2014	July 2014	Merge of CY40T1 and CY40R2
	CY41R1			Sept 2014	Merge of CY40R3 and CY41
	CY41R2		Deadline for changes: Dec 2014	Feb 2015	Scientific and OOPS technical changes incl.
		CY41T1	End of Nov 2014 = deadline for contributions	March 2015	Build this cycle (phasing) over Dec 2014 – February 2015
CY42				March-June 2015	
	CY42R1			June or July 2015	Final changes for HIREs
	CY42R2				
		CY42T1		Mid-Oct (start 12/10 ?) through mid-Dec 2015	Dates to be confirmed



CY43			March 2016	April-June 2016	Start of merge to be confirmed; MF will need to complete the verification of aptitude of its BULL Phase 2 cluster by end of April
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Note: CY43 might be built as the merge of CY42R1/R2 and CY42T1, plus additional changes coming from the refactoring of the observation operator codes for OOPS. The latter issue will require coordination between the IFS-Arpège management and the OOPS management. The precise technical planning of the phasing steps for CY43 will be discussed in due time.

For the start of merge of CY43, MF was suggesting to keep an alternative timing (w/r to beginning of April) which would be beginning of May, but this possibility would require further discussion.

## 10. AOB

## 11. Next meetings

### Next technical video-conferences:

- Tuesday 23 April 2015, 1.30pm UK / 14h30 MEST

### Next Coordination video conferences:

- not yet decided

**Next Coordination Meeting in Reading:** Monday 15 June 2015 in Reading (EC)

### List of actions

- 1 Recommendations about Fortran/C++/Boost standards for benchmarking and call for tender specifications => for FORTRAN, F90 is mandatory, but support for F2003 is highly recommended for any new HPC for IFS-Arpège-LAM partners. A list of specific F2003 features, agreed in the technical IFS-Arpège videoconferences, is mandatory for recent cycles (the list is available by

Deborah or Claude). For C++ and Boost, Claude to liaise with Yannick.  
(action)

- 2 A regular cross-exchange of information and possibly coordination decisions should be ensured between the OOPS Project per se, and the IFS-Arpège-LAM code collaboration. It was suggested that this aspect could be discussed at one of the forthcoming OOPS Board meetings. Action on Claude and Deborah.
- 3 Steve to send MF material in preparation by Elias Holm, about the impact of the changes in the EDA on the performances of the CY41r2 IFS E-suite.
- 4 Sylvie to send participants the slides of her presentation about the cubic octahedral grid in IFS. Claude to disseminate in GMAP.
- 5 Deborah to check with Olivier Marsden for the status of the Python script and the tests for passing FIELDSETs (GMVs, GFLs) by list of arguments in the model code. Contacts at MF: Claude and Alexandre Mary.