

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: RD16-xxx

Subject: Minutes of the IFS/Arpège coordination video-conference held on 18 October 2016.

Participants:

Météo-France: François Bouyssel, Claude Fischer, Ryad El Khatib, Stéphane Martinez, Yves Bouteloup, Alexandre Mary

ECMWF: Stephen English, Deborah Salmond, Peter Lean, Sylvie Malardel, Robin Hogan (Sylvie and Robin for the start of the meeting only)

ALADIN: Piet Termonia (excused)

HIRLAM: Daniel Santos-Muñoz (excused)

1. Adoption of Agenda

adopted

2. Approval of Minutes of meeting of 6 June 2016

approved

Note: minutes from the 13 October technical video-conference also are available, and can be obtained from Claude.

3. Review of list of actions from last meeting

1. Action on Deborah: provide an initial proposal of F2008 suggested features for IFS-Arpège.
=> *Deborah will list those elements of F2008 that already are present in the IFS codes (usually under key-protected switches). This list could be a starting point for discussing*

items that could/should be accepted or be tested on various compiler versions and computer platforms. Action open.

2. Prototype of a new Confluence page to share information about IFS-Arpège cycles (bugs or fixes). Action on Deborah: propose a reviewed list of descriptive elements for the Confluence page, based on specific examples of recent fixes. => *Action closed. Steve recalled that the core idea behind the Confluence page really is to list or document existing problems of the codes, either suspected bugs or porting issues. EC and MF will start checking which existing issues could be relevant for the Confluence page, and start document them. Action on both EC (Steve and Deborah) and MF (Claude, François). The content of the page will be reviewed in the forthcoming coordination meetings.*
3. Action on MF: provide EC with the source code of CY43T1 asap, possibly based on the forthcoming pre-release version 4 (Stéphane, Claude, to Deborah). => *Done, action closed.*
4. Action on EC: send the ATLAS technical documentation as soon as ready. => *Done, action closed.*
5. Action : EC to send the specs and code (in CPG_DRV tree) of the re-factored GMV/GFL structure to MF ; for MF to evaluate them and provide feedback asap. This action could take place over July/August. => *Done, action closed.*
6. Action on EC (Peter): to send MF Peter's technical note about the evaluation of the performance and cost of the IFS Screening. => *Done, action closed. Peter explained that he had just started to investigate the issue of improving the co-localisation of obs and model data on the same MPI task (geographical remapping of the obs).*
7. Action (Deborah): to describe the IFS bugfixes found while porting the codes to the Cray Broadwell PE cluster, on the IFS-Confluence page. => *Done, action closed.*
8. Deborah will provide a library-link release note for CY44_main, in order to list the versions of OOPS, Atlas etc. that should go with IFS CY44. => *Action open.*

Preliminary note: the following files/slides were presented at the video-conference, and can be obtained from Claude (on demand):

- *progress and plans at MF (by François)*
- *progress and plans at EC (by Steve)*
- *new radiation code ECRAD (by Robin)*
- *updates in the observation codes (by Peter)*

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

François recalled the main operational applications of MF's NWP system (Arpège, PEARP, AEARP, Arome, soon PEARO, Arome Overseas, Arome-NWC). The migration to the BULL Phase-2 clusters has been completed since beginning of October. The convection-permitting EPS (PEARO) based on Arome has a pre-operational status and an official operational tag should be decided in December 2016. PEARO brings a visible added value for the probabilistic scores of short term fields such as precipitations (seen for instance on Brier skill scores).

The 2016 E-suite is now being handed over from Research to Operations. It is based on CY42_op2 (thus, extra changes in a specific branch on top of the CY42 joint with IFS). It contains:

Description for Arpège / AEARP (EDA) / PEARP (EPS):

- New convection scheme PCMT in Arpège and AEARP
- SURFEX model (surface parametrisation)
- AEARP: resolution increase for the computation of background error variances
- AEARP: normalisation of variances induced by wavelet modelling of correlations
- VarBC on ground GPS observations
- Assimilation of 2 water vapour channels (183GHz) of GMI on GPM
- Assimilation of 3 water vapour channels (183GHz) of MWHS2 on FY3-C
- Higher density of GEORAD (from 250 to 125km)
- Assimilation of window SEVIRI channels (4, 6, 7, 8 over sea)
- 5 new channels (ozone) for IASI
- New physics in PEARP (ARPEGE EPS)
- Optimisations (new compiler version, etc.)
- New diagnostics (domain, variables, etc.)

Description for Arome

- Same modifications as in Arpège for observations
- New version of IAU
- New cloud optical properties
- New auto-conversion threshold for transformation of cloud droplets into rain
- Ocean mixing layer scheme in Arome-OM (Overseas versions of Arome)
- Optimisations (new compiler version, server for production of AROME-EPS coupling files)
- New diagnostics (domain, variables, etc.)

The scores of the E-suite version are overall very positive, compared with the CY41T1_op1 operational version. Some deficiencies are seen on the bias and stdev in the low stratosphere, but these aspects would probably not prevent a switch to operations, which is planned for about March 2017.

The plans for 2017-2018 are:

- migration to VORTEX for operational suite
- Arome-EDA
- Arome-EPS and Arpège-EPS 4 times/day
- New horizontal resolutions for Arpège (about 5km over Western Europe), AEARP (EDA) and PEARP (EPS)

And also:

- Physics : new surface schemes in SURFEX, 2 moments microphysics scheme “LIMA”, coupling with ocean and wave models, etc.

- DA : 4DEnVar data assimilation
- Observations:
 - aircraft humidity data,
 - VarBC for aircraft data,
 - European radar data (OPERA),
 - Lidar winds from ADM/AEOLUS,
 - assimilation of new scatterometer data (ScatSat),
 - preparation for IRS/MTG,
 - consider new satellites (FY3-C, FY3-D, JPSS1, etc.),
 - all-sky microwave radiances using a Bayesian inversion approach, etc.

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

Steve presented the content of CY43R1, which is scheduled to enter operations on 22 November:

Atmosphere

- Updated ozone climatology
- Scaling of convective mass fluxes for high resolution and change to mass flux limiter
- Correction to up-draught momentum and environment for shallow convection
- Modification to VDF (turbulent mixing) cloud scheme to remove spurious ice cloud
- Assimilation of NEXRAD snowfall
- More up-to-date total solar irradiance value and minor radiation bug fixes
- Change resolution dependence of non-orographic gravity wave flux from TC-grid (spectral) to TCo-grid (dx)

Land Surface

- Adjustment to the evapotranspiration computation by shutting it down when the first soil layer is frozen
- Modify land surface coupling coefficients to reduce diurnal cycle T2m errors

Wave

- Limitation on the ocean wave spectral steepness for high winds and minor adjustment to the wind input gustiness parametrisation calculation

Ocean

- New 0.25° 75L Ocean model plus ocean DA for ENS
- New perturbation strategy for surface fluxes and observations error
- Improvements in ocean observation quality control
- Online comparison with SMOS sea-ice thickness
- Introduction of stability checks for ocean bias correction

Model uncertainty

- Global fix for tendency perturbations in SPPT to improve conservation of humidity

Assimilation

- Reintroducing model error forcing in the stratosphere levels 1-44 using a new model error covariance matrix

- Increase in the resolution of EDA variance (SES) calculation to TL399
- New wavelet noise filter for EDA variances (SES) based on TCo639 EDA's
- New climatological covariance matrices based on TCo639 EDA's
- Introduction of OSTIA based SST perturbation in the EDA, from ERA-5
- Introduction of a vertical structure function in the screen level analysis

Observations

- Updated observation error covariance matrices (with inter-channel error correlations) for IASI and CrIS
- Updated ozone anchor channels for IASI and CrIS
- New channel selection for CrIS (going from 77 to 117 channels)
- New aerosol detection scheme (independent from cloud detection) for IR sounders (IASI, AIRS and CrIS)
- Slant-path radiative transfer for all clear-sky sounder radiances

The score boards compared with CY41R2 are very favourable to the new version, with some negative impact only for temperature in the Tropics (250hPa), 2m temperature in the Tropics and 2m dew point temperature (more globally). Probabilistic scores (CRPS) exhibit an improvement for geopotential, mean sea level pressure and wind speed. Some deterioration noticed on precipitation in the Tropics.

CY43R3 is now in its final phase of build, and should become the basis for the upcoming E-suite that is expected to start in R&D mode in December 2016. There will be new optimizations in the use of observations, for load balancing improvements when handling the CCMA database and ensure reproducibility of the sequence numbering of observations. The latter will be under switch (can change the results w/r to the reference). These changes concern the observation processing in "ifstraj". Action: Peter will send information about the switches and changes to MF.

Further plans so far encompass (*see also discussion about the cycles plans in Section 9*) :

- CY44: Joint cycle, early 2017 ?
- CY44R1: General science cycle
- Contributions: 01/03/2017; Operational 15/10/2017
- CY44R2: Overlapping 12h 4D-Var
- Contributions: Autumn 2017; Operational Spring 2018
- Later (2019 ?): OOPS implementation cycle

6. HIRLAM comments

7. ALADIN comments

8. Specific issues:

8.1. ODB and COPE (Peter)

Peter gave an update about the new “ifsobs” software layer that is deemed to enter the IFS codes as an interface between the Fortran and the ODB. The roll-out will continue in CY44R1 but the work will likely not be complete until 2018. It will be complemented by specific codes for “obsdist” and “obsort”. Those would be called at the beginning / end of the Screening stage, resp. In “obsdist”, a new geographical remapping of the observation locations per MPI tasks would be implemented, in order to increase the co-location of observation and model-equivalents in MPI tasks, and thus reduce the needs for communications in the screening. The “ifsobs” codes would appear in the joint cycles as a new project in the SCR, and thus require adaptation in the compile/build systems. EC plan to retire the old “cma2odb” software by 2018.

Peter stressed that the new codes should work basically from scratch for any obs type, and both for IFS or Arpège observation processing in the screening. MF mentioned that the new codes might have an impact on the specific radar vertical profile retrieval computation, which is part of the Arome screening step (Note: the algorithm checks for neighbourhood profiles of modelled T and RH, based on a Bayesian distance function computed over observed versus simulated reflectivity columns). Eric Wattrelot would be the contact person at MF. (*Note: no specific action suggested yet on this item*)

Claude asked whether EC had any experience or result with the control of the minimal distance of observation positions after thinning was passed. Indeed, for some Arome experiments, MF noticed that the final distance between observations could be much shorter than the minimal distance prescribed in namelist (RMIND_*). Peter explained that this behaviour actually could be normal, for instance when after the first pass of thinning two selected observations are near to the same border of two adjacent boxes. If this happens, it could be enough to prescribe a larger thinning distance in the second pass (RFIND_*) so that thinning is performed with coarser boxes. Claude suggested that MF might check more in details whether this situation is encountered more frequently in the relatively small boxes prescribed for Arome. Action on Peter and Claude: to further liaise as necessary and exchange information or suggestions on the thinning method. At MF, Vincent Guidard will be kept in the loop.

8.2. Continuity equation proposal (Sylvie)

Sylvie explained that EC will implement the mass preserving option $\delta m=1$ in the IFS time stepping. This option is required by the Chemistry group from Copernicus (CAM Section, ex-Macc), in particular the CO2 people. The impact in their climate runs is clearly beneficial. This will require a change in the dynamics code (unlike in Arpège/Arome because of the different physics-dynamics calling sequence). Sylvie and Karim agreed on how to control this option inside the dynamics (use variable NDPSFI, keep the routine that computes w transparent to this option, use other keys like LEPHYS or LSLPHY as appropriate). The code change shall enter CY44. Action on Sylvie: send the technical and scientific note about the results with the mass-preserving option in IFS to MF, when ready.

8.3. New radiation code (Robin)

Robin gave a status report about the progress with coding the new radiation scheme ECRAD, and implementing it in the IFS. The new code is more modular than the present operational ones (RRTM, SRTM), and will enable to change much more easily specific components of the radiation parametrisation, like changing gas or cloud optical properties, aerosol properties, the RT-solver etc. The new code also is significantly cheaper than the operational one, by about 34% in runtime and 2.5 times less expensive in memory, which could allow to call the full radiation code every 2h (instead of 3h) in the operational context. The new ECRAD code will be available in CY44, with further improvements planned for 2017 (see in Robin's slides for more details).

An ECMWF memo is in progress, and shall be distributed via the usual official ECMWF channels.

François mentioned that MF will soon hire a new staff who will be in charge of working on R&D of the radiation schemes. His name is Quentin Libois. He will be part of the GMME group, the mesoscale research group that's heavily involved in the development of the Méso-NH (and Arome) physics. Quentin's tasks will however probably also encompass efforts for the global models (Arpège, Arpège-climate).

8.4. OOPS Wrap-up

Several re-factoring aspects had been discussed at the technical video-conference of 13 October (minutes available from Claude):

- the GMV/GFL/Surface buffers re-factoring will first concentrate on the reorganization required for constructing the STATE and more importantly the INCREMENT object from OOPS (Mats Hamrud). This will enter CY44.
- Also the new Trajectory code for 4D-VAR in OOPS should be ready for CY44 (Olivier Marsden). The new trajectory code will only work for building a trajectory for OOPS-VAR and will enter the IFS codes rather as a shallow layer of extra code. For the “classical” IFS-VAR, the old trajectory codes will remain in use.
- Roel Stappers (visitor scientist from Met.no) is working with Yannick on MFLA (C++), implementing Unit tests in the PREPIFS suite, and helping in the re-factoring and testing of the VarBC component in OOPS (with Alan Geer).
- The MODEL object will require a heavy code re-factoring (in terms of number of source files changed), for encapsulating and reorganizing the variables. It was assumed that the model variables should be grouped for dynamics, physics, and then chemistry etc. Perhaps even more refined groupings could be envisaged later (but are not necessary for OOPS). The work will start with writing down the list of the various variables and their groupings, then the actual rewrite is expected to be performed by applying a specific Python scripting (SPAM-type) and manual final correction (usually always required). This will be done in close coordination between EC and MF (Olivier Marsden for IFS, Karim Yessad/Yves Bouteloup/Alexandre Mary for Arpège, Arome etc.). The MODEL object re-factoring is considered as the last big bit of re-factoring that is missing for OOPS-IFS, and will enable to start testing multiple instances in 4D-VAR.

- Tests of simple 4D-VAR have just started at ECMWF. At MF, further porting of OOPS-VAR prototypes on CY43 is awaiting for the validation of the Arpège assimilation with the CY43 joint codes (this is work in progress in GMAP).
- Full-POS for the PostProcessor object should be further evaluated and adapted. Ryad, Etienne and Claude will start discussing the requirements for this task.

At the 13 October technical meeting, the proposal to make a quick technical CY45 a few weeks after CY44 was discussed, and it was indeed suggested to bring this proposal up at this coordination meeting. See Section 9.

9. Content and timing of cycles

The table below is provisional (updated from before the meeting). The actual decisions for the 2017 cycling plan were left open. Several options have been considered, in broad lines depending on whether a quick technical cycle CY45 should be done a few weeks after CY44 or only in the autumn 2017 (as a full science cycle then). There was a consensus at the meeting for considering the technical cycle soon after CY44, but its precise content and timing should be further checked. For instance, it seemed worth checking whether the technical cycle can include other re-factoring items in addition to the MODEL item (like VarBC, LTOVSCV, other ?). This option might however make the build of CY45 more complex, and extend its construction time.

The build of the technical cycle CY45, a few weeks after CY44, was eventually retained as the best scenario, but an evaluation of whether the follow-up interim cycles (CY45R1/R2, CY45T1) and the next joint cycle (CY46) could be delayed over the autumn and the end of 2017, respectively, needs to be done. Action on Steve and Claude to check with their respective management and staff, and liaise as appropriate.

Joint cycle	ECMWF	MF	Start of phasing	Declaration	Misc. / Oper plans
CY42				June 2015	Declared 17 June
	CY42R1		end of June 2015	July 2015	Could be implemented with resolution upgrade but not essential
	CY42R2		September 2015		
		<i>CY42T1</i>		<i>Cancelled in order to prepare for CY43 which was rescheduled after the last coord meeting</i>	<i>Dropped</i>
		CY42_op1 / op2	March – September		MF E-suite version expected for

			2016		operations by March 2017
	CY42R3				Will contain refactoring on top of R2 (only)
CY43			September 2015	February 2016	Declared 25 Feb.
	CY43R1		March 2016	June 2016	Scientific changes
	CY43R2		September 2016	November 2016	Re-factoring for OOPS
	CY43R3 ?		?	?	Model, DA changes ?
		CY43T1	April – June 2016	June 2016	Including Aladin and Hirlam
		CY43T2	September – October 2016	Expected for declaration by 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.
	CY44R1		March 2017	June 2017	
		CY44T1	April 2017 (start about 18/04/17 tbc)	June 2017	
CY45			Beginning of October 2017	December 2017	Timing to be confirmed

10. AOB

None.

11. Next meetings

Next technical video-conferences:

- Tuesday 22 November, 14h30 CET / 1.30pm UK

Next Coordination video conferences:

- Tuesday 21 February 2017, 14h30 CET / 1.30pm UK

Next physical Coordination Meeting:

Monday 12 June 2017, meeting to take place in Reading

List of actions

1. Deborah will list those elements of F2008 that already are present in the IFS codes (usually under key-protected switches). This list could be a starting point for discussing items that could/should be accepted or be tested on various compiler versions and computer platforms
2. EC and MF will start checking which existing issues could be relevant for the Confluence page, and start document them. Action on both EC (Steve and Deborah) and MF (Claude, François). The content of the page will be reviewed in the forthcoming coordination meetings.
3. Deborah will provide a library-link release note for CY44_main, in order to list the versions of OOPS, Atlas etc. that should go with IFS CY44.
4. Action on Sylvie: send the technical and scientific note about the results with the mass-preserving option in IFS to MF, when ready.
5. Peter to send information to MF about the switches and changes in the use of observations in CY43R3 (improved optimizations for CCMA, reproducible sequence numbering)
6. Thinning strategies and minimal distance between selected observations (Arome case). Action on Peter and Claude: to further liaise as necessary and exchange information or suggestions on the thinning method. At MF, Vincent Guidard will be kept in the loop.
7. Cycling strategy in 2017 (CY45, CY46). The build of the technical cycle CY45, a few weeks after CY44, was eventually retained as the best scenario, but an evaluation of whether the follow-up interim cycles (CY45R1/R2, CY45T1) and the next joint cycle (CY46) could be delayed over the autumn and the end of 2017, respectively, needs to be done. Action on Steve and Claude to check with their respective management and staff, and liaise as appropriate.