

IFS/Arpège Phone Call Memorandum

From: Claude Fischer (MF)

To: (ECMWF) HR, RD Division & Section Heads, Deborah Salmond, Anne Fouilloux, Yannick Trémolet, Mats Hamrud, Mike Fisher

To: (Météo-France) Arpège diffusion list

To: (ALADIN) *Observer position presently open*

To: (HIRLAM) Xiaohua Yang

File:

Subject: Minutes of the IFS/Arpège phone call - towards Cycle 37 - held on 16th March 2010.

Participants:

Météo-France: Alain Joly, Claude Fischer, François Bouttier, Ryad El Khatib, François Bouyssel, Patrick Moll, Karim Yessad, Stéphane Martinez, Guillaume Beffrey and Philippe Marguinaud

ECMWF: Jean-Noël Thépaut, Anne Fouilloux, Deborah Salmond, Mats Hamrud, Yannick Trémolet, Mike Fisher

ALADIN: ()

HIRLAM: ()

0. Adoption of the agenda (all)

adopted

1. Approval of Minutes of last teleconf meeting and Action status (all)

1. DS, REK, KY and Tomas Wilhelmsson to look at evolution of Arpège/IFS coding norms. This will be discussed during Ryad's stay at ECMWF in early December (8/12). => **closed**
2. Preparation of ECMWF's IPR guidelines: CF to further liaise internally and with JNT about possible comments or changes proposed by MF for the IPR document. => further discussions will take place between ECMWF and MF General Directions => **action held on**
3. JNT and CF to look at current agreement between MF and EC to see if it needs updating in view of HIRLAM. JNT will check internally with E. Kallen

and D. Marbouty. Action to be continued: make a new status of this document at the next phone call. => *same as item 2*

4. DS, JNT, CF: confirm timing for CY37: try to settle the dates for CY37 in December 2009 (contact between AJ/CF and JNT/DS). => *see point 4 in the agenda*
5. MH, KY and REK to find a way to not split SUGAW: it is not yet clear whether Mats will provide the upgraded code (with the agreed split of SUGAW in the setup) of Karim. DS will check with MH what is the situation at ECMWF. Action to be continued (DS, MH, KY, CF). => *closed*
6. Surface buffers as potential source of bugs: Deborah to hand over Karim's document to Lars Isaksen and Drasko Vasiljevic. Then wait for some possible feedback from them. The doc is still under investigation. Action to be continued. => *ECMWF will write down a short note about the recommended procedure for adding new fields in GOM arrays; MF (Karim) has provided a note for GFL new variables. Work on surface buffer and dataflow is not foreseen for the time being => original action closed; new action on the GOM-note*
7. MF shall send the source code of CY36T1 (at least, for "arp/ifs" directory) to ECMWF after the cycle is completed. => *closed*
8. ECMWF will send the bugfix for solar/RRTM and appropriate documentation to MF => *closed*
9. ECMWF shall send the source code of CY36R2 (at least the "arp/ifs" directory) to MF for cross-checking on the code cleaning (and preparation of the phasing for CY37) => *closed*
10. Changes in the ODB tables and descriptors in link with the archiving of ODB in MARS: MF shall check internally for comments and possible further questions or suggestions towards ECMWF => *to be further checked between ECMWF and MF (Anne and Dominique Puech); action to be processed promptly*

2. Progress and Plans of ECMWF (JNT)

CY36R1 High Resolution Implementation

Configuration:

- Deterministic model: T1279L91 (~16km)
- Outer loop of 4D-Var T1279L91 and inner loops (T159/T255/T255)
- EPS resolution T639 (to 10 days) and T319 thereafter
- Wave model (25km and 36 directions)

E-suite started 25 September 2009, and restarted after a bug correction in the radiation scheme

The implementation took place on January 26 2010

Status of CY36R2

Use of EDA-based perturbations in the EPS

Revised SPPT in the EDA

Forecast Sensitivity to Observations (diagnostic tool)

Technical code optimisation

The e-suite is currently being set-up with an operational target for mid May 2010.

Plans for CY36R4 (note that with the delay in the implementation of CY36R2, it has been decided to fold CY36R3 and CY36R4 in one single cycle which will be assembled together by mid-may 2010).

Content of CY36R3/CY36R4:

- Vertical diffusion changes to reduce diurnal cycle amplitude of 2m temperature
- Dissipation of convection momentum transport included in heat budget
- Seasonal Leaf Area Index
- Extended Kalman Filter surface analysis (with assimilation of ASCAT and monitoring of SMOS)
- Representation of AMV error correlations
- Enhancement of all-sky satellite data assimilation system and mode-based VarBC
- Prognostic rain/snow
- Optimizations to convection and clouds (tropical issues)
- Introduce effects of currents in European shelf wave model
- Assimilation of scatterometer winds as neutral winds
- Introduce new Jb statistics
- EDA based flow-dependent variances in 4D-Var
- Bias correction for Aircraft temperatures
- Activation of IASI/AIRS ozone channels

In addition to the above list, it is planned for CY36R4 to introduce some modifications to the snow analysis (and use of NESDIS snow products) and possibly replace the current Cressman analysis by an OI scheme.

The increase of number of vertical levels will be introduced after the common cycle CY37 and is targeted towards the end of the year (this will be a priori the only ingredient of CY37R1).

3. Progress and Plans of Météo-France (CF)

- ARPEGE and ALADIN-France E-suite (autumn/winter 2009/2010):
 - CY35T2
 - new change of resolution of ARPEGE: T798C2.4L70
 - new resolution for the 4D-VAR analysis increment: T107C1.0L70 (25 iterations) and T323C1.0L70 (30 iterations) with $\delta t=1350$ s; the benefit of moving to 3 outer loops and minimizations has eventually not been clearly seen, thus the multi-incremental 4D-VAR will stay with 2 outer loops
 - changes in the assimilation ensemble: L70
 - Double the density of about all radiance types (change the scale of data use from one spot every 250 km to one every 125 km)
 - assimilation of NOAA-19 channels;
 - reactivate VarBC for channel 13 of AMSU-A
 - extend the number of assimilated IASI channels (surface channels and WV channels),

- introduce a bias correction for MSLP and T observations (based on ECMWF practice)
- retuned error standard deviations: REDNMC from 2.0 to 1.6; σ_0 multiplied by 0.9 globally
- Physics: new moist simplified physics version for TL/AD (based on Smith) including some microphysics;
- ALADIN-France: L70, slight increase of resolution to about 7.5 km

This E-suite is expected to switch to operations by mid-April 2010.

- AROME-France E-suite (over the same period) :
 - CY35T2
 - AROME will inherit some of the ARPEGE/ALADIN changes (doubled radiance density, NOAA-19), and gain new features (AIRS, IASI, SSMI assimilation, activate VarBC for SEVIRI)
 - Assimilation of radar reflectivity
 - Increased vertical resolution (60 levels)
 - Activation of an upper level sponge towards the coupling model (in the forecast), based on the spectral coupling formulation
 - Direct lateral boundary coupling between ARPEGE and AROME
 - test new choice for B-level parallelization (made possible after correcting an old, sleeping bug in the B-level decomposition of LAM Semi-Lagrangian advection scheme)
 - new version of shallow convection (to increase the persistence of Sc clouds)
 - new version of CANOPY, including a fix to allow proper initialization of CANOPY fields at timestep 0
 - one fix to prevent negative values on some water species contents

This E-suite is expected to switch to operations by mid-April 2010.

- One important change has taken place in the Computer Centre over February/March 2010, with the successive upgrades of the two NEC/SX9 clusters (add more CPU on each of them). This upgrade has required to shut down successively each cluster for about two weeks, and new Acceptance Tests have been done. This work has led to some slowdown for R&D activities taking place in the 10/02/10-14/03/10 period. The final configuration of MF's computing system now is: a R&D dedicated SX8R cluster ("TORI") with 32 nodes, a R&D SX9 cluster ("YUKI") with 10 nodes, an Operations-devoted SX9 cluster ("KUMO") with 10 nodes.

Possible contents of the 2010/2 E-suites:

- provisional "summer E-suite" (June/September 2010) ((* stands in front of priority items; (**) for even higher priority !):
 - CY36T1
 - Assimilation (global 4D-VAR as reference):
 - monitoring of SSMI/S
 - assimilate more wind profilers (*)
 - radiosonde bias correction scheme imported from IFS
 - assimilation of GRAS/METOP (*)

- assimilation of some cloud-affected IASI
 - assimilation of more AMSU channels over sea-ice surfaces (*)
 - upgraded OBSTAT code to take into account radar reflectivity and RH profile retrievals (would probably become part of an official CY36T2 release)
 - inflating factor for σ_b 's for taking into account model error
 - use of ensemble assimilation σ_b 's in the screening
 - use of OSTIA SST analysis
- Arpège/Aladin-France upper-air physics:
 - Cloud sedimentation scheme
 - ISP modelled satellite imagery
 - Extra diagnostic outputs of cloudiness, Liquid water content, Ice content, Turbulent kinetic energy, hourly outputs for surface fields
 - Improved diagnostic scheme for computing the 0 deg. C. height
- Implementation of SURFEX in some of MF's Aladin model applications (France, Overseas, ...)
- Arome-France:
 - 80km thinning for IASI pixels (*) => ***ECMWF mentions that IASI water vapour channels have been found to have a significant horizontal error correlation (Vincent Guidard may contact Nils Bormann on this issue)***
 - revisit the blacklist for radar data; assimilation of more coastal radars (*)
 - Extension of the size of the horizontal domain (**)
 - Code optimization for fitting the requested elapse time for Arome/large domain: inside the ETKF shallow convection code, inside the I/O and message passing communications (especially in link with SURFEX) (**)
- Possible “winter E-suite” (start in November or December 2010):
 - CY36T1 (maybe CY36T2 but this choice is pending on the level of difficulty for validating this cycle in a probably limited amount of time)
 - PEARP: increase horizontal resolution
 - Assimilation (4D-VAR Arpège):
 - assimilation of 2 more Clear Sky radiance channels (CSR) from MSG; assimilation of GOES CSR
 - assimilation of some Synop data over land in Arpège (already assimilated in the Aladin and Arome 3D-VAR)
 - flexible choice for cloud detection scheme for HIRS
 - maybe, force to zero the bias correction for upper-air IR channels
 - assimilation of IR channels over land
 - implement the decoding of Aeolus data and clean that code

- Arpège/4D-VAR simplified physics: either a new convection scheme, or a modified turbulence, if not already provided for the previous E-suite (will require at least CY36T2)
- Arpège/Aladin-France physics and surface treatment:
 - Aladin-France + Surfex + new surface assimilation code “OI_main” (will probably require CY36T2)
 - 3MT-based convection in Arpège/Aladin, if found beneficial
- Arôme-France:
 - Make the specifications for microphysics parameters consistent between the model and the obs operator parts (for reflectivity operator)
 - Insert the code for taking into account the partial orographic mask inside the radar operator (collaboration with G. Haase from SMHI/Sweden, Hirlam)
 - Surface assimilation (“OI_main”)
 - Hail as additional prognostic variable for the microphysics and/or ECOCLIMAP2 physiographic surface database

MF/Harmonie interim cycle before CY37:

CY36T2: the proposed deadline for contributions is by end of April – or a bit later - 2010. Due to the shutdown of the SX9 clusters over parts of February and March, followed by the Eastern holidays in France, this cycle should be prepared from mid-May through June. Provisional content:

- Assimilation:
 - Cleaning of Neural Network routines for AIRS (V. Guidard)
 - Adaptation of code to use the ECMWF bias correction for radiosonde and SYNOP at Météo-France (P. Moll)
 - Microwave radiances:
 - Addition of emissivity parameterization using a Lambertian approximation for refractivity (F. Karbou) and compare with the specular hypothesis,
 - Infrared radiances:
 - Computation of cloud top pressures for cloudy IASI radiances (performed once during screening with a different formulation than in the IFS, V. Guidard and N. Fourrié). Same development already is operational for AIRS.
 - Introduction of an alternative cloud detection method for AIRS and IASI (MMR code from Thomas Auligné), unless similar work planned at ECMWF (V. Guidard or N. Fourrié) – to be confirmed
 - Snow analysis updated code in CANARI (F. Taillefer, M. Homleid, L. Taseva)
 - Catch-up of code for radar reflectivity if not already in the “_bf” branch of CY36T1 (E. Wattrelot)

- Finalization of the Optimal Interpolation code within the SURFEX framework (so-called “OI_main” code); the core part of this code, which is to replace the old ISBA surface analysis code in CANARI, already is introduced in CY36T1 (F. Taillefer & J.-F. Mahfouf)
- Optimization of 4D-VAR for NEC/SX9, based on the work in early 2010 (E. Sevault, R. El Khatib, P. Moll)
- Arpège/Aladin physics:
 - Adaptations for using 3MT (modular multi-scale microphysics/turbulence) – J.-M. Piriou
- Arpège simplified physics schemes (O. Rivière):
 - Modified gravity wave drag scheme (by ignoring the perturbations of some terms)
 - New large scale precipitation scheme: adjustment Smith scheme ($Q_v \Rightarrow Q_v^*, Q_l^*, Q_i^*$, cloud fraction) followed by auto-conversion and precipitation of all condensed excess (Q_r^*)
 - Convection scheme based on a simplified Betts-Miller scheme
- Arome:
 - Optimizations for NEC/SX9 if not already present in the “_bf” branch of CY36T1 (Y. Seity)

Further code contributions that may be ready for inclusion in CY37 are (to be confirmed):

- A thorough overhaul of the SURFEX to atmospheric models interface, in order to improve its robustness and prepare for further optimizations (make it Open-MP proof)
- An overhaul of the physics/dynamics interface (CPTEND, CPUTQY) in collaboration with the Aladin/ALARO partners
- Extension of the MSG/SEVIRI raw radiance assimilation in the LAMs (Aladin and Arome) to cloudy radiances (S. Guedj)
- Cleaning of the MF_PHYS interface (reduce substantially the number of dummy arguments) – Y. Bouteloup
- Extension of 901 to match requirements for Interoperability (I-SRNWP) – J.-M. Audoin (probably ... not => this code would remain outside official releases)
- Code for generating frame-formatted lateral boundary conditions from the IFS, and alternative bi-periodization method – L. Auger (+ G. Kerdraon for some specific harmonization work)

4. Content and timing of CY37 (CF, DS, JNT)

ECMWF will send a preliminary version of CY36R4 to MF before the next coordination meeting (June 24), for visual inspection (in preparation of the actual phasing in the autumn) and preliminary testing at MF. This early sending shall also ease some code overhaul planned at MF during the summer. The phasing towards CY37 shall take place from end August until mid-October. A fair first guess for sending the code back to ECMWF could be October 11th (Monday).

5. GRIB-API issues (DS, REK)

MF still has problems with porting GRIB_API on the NEC/SX9. There are bugfixes to be included in the official ECMWF release (liaison Ryad/ Enrico Fucile) and then MF will perform a thorough check of the performances:

- conversion program grib => FA file (grib_api in read mode)
- a test program for writing out grib files (Deborah will send the code to Ryad)
- possibly, if required, a low truncation IFS forecast

Mats mentions that vectorization problems in sbyte/gbyte should be looked at. He will help on these aspects.

6. Status on OOPS (YT, JNT)

The potential interest of OOPS, and the discussions on manpower requirements, have been quite extensive at ECMWF between the core team group, Jean-Noël, Erland Källén and the management level at the Centre. These discussions shall be resumed and completed in the coming weeks. Then, firm decisions about resource requirements, manpower investment and the official green light to start the work should be issued. Several extra resources already have been identified:

- 1 full time position for 2 years (staff from Reading University)
- 1 staff contracted jointly by ECMWF and the Met Office (for ODB support) would work part time for OOPS (on the obs operator interfacing)
- 1 full time for 1 year from IBM
- internal staff resources still have to be discussed

ECMWF plans to use the toy models for practical data assimilation sessions in the next training course in May. At that time, the toy model would be given away to the participants.

MF indicates that it will need to study the toy model code now rather soon, in order to start familiarizing its staff both with OO coding and with the toy code itself. This is crucial now since ECMWF has built the toy in order not only to mimic the IFS, but also to get a fair guess of how the future OO control level of the IFS will look like (some of the OO high level abstract toy code should be reusable in the IFS, actually). The present development phase in the toy at ECMWF consists in implementing a flexible multi-observation obs operator interface, and hiding the ODB structure inside that interface. ECMWF nevertheless will send MF a new version of the toy program as soon as possible, so that MF staff can start getting familiar with this code, and possibly “play” with it.

MF would be interested in an OOPS training session. The proposal is that one or two ECMWF staff can come to Toulouse in order to give the tutorials for MF (and possibly some Aladin/Hirlam) staff. Claude and Jean-Noël shall check how to organize this (including the most suitable dates).

ECMWF prepared before the phone call some input documentation on project management and task description for OOPS (GANTT chart, task description). About the evolution of coding standards, MF will review ECMWF's proposal in light of the already existing Fortran coding norms (Ryad) and propose an updated document

(especially, MF would wish to keep a documentation that can lead to a norm checker facility). ECMWF will propose guidelines for C++ coding based on earlier drafts by Baudouin Raoult.

One other crucial task will be the “IFS_cleaning” part. ECMWF expects to devote 2 full time staff plus the help/investment of experienced IFS people there. MF thinks that the preliminary phase of code analysis, specification and scope of this exercise will be important and should be re-assessed with respect to the proposed calendar. The “cleaning” task seems to be fairly transversal and will in practice affect all other tasks listed in ECMWF's input document (DA, TL/AD, dynamics, physics, ...). MF also states that the initial discussions between MF and ECMWF core teams will address those important aspects (which pieces of code to agglomerate, new interfaces, scope of the code restructuration, especially depth of the recoding with respect to the model time step organization). Only then, should the actual recoding phase start. ECMWF recalls that OOPS is not going to re-address the scientific content of the IFS. Mostly, options and results should remain untouched.

For MF, the “LAM task” also should be re-evaluated as this also is going to be a very transversal aspect (*the LAM Fortran code deeply is inter-connected with the global one, red.*). The toy model hopefully can serve as a basis for understanding how the concepts of OO can help articulating the LAM code with the global one (polymorphism, inheritance, ...). Work with the toy on LAM aspects probably will have to take place in parallel to the initial discussion about IFS cleaning (restructuring), though the first item should influence the second one.

Jean-Noël and Claude shall liaise and further adjust the initial managerial documentation to the expected requirements, for the next coordination meeting in Toulouse.

7. Status on IFS scalability / EnKF developments (MH)

Mats has written a Tech memo (available at <http://www.ecmwf.int/publications/library/do/references/list/14>) describing the findings on scalability for IFS' major configurations, with a special focus on the 4D-VAR system. His conclusion is that there is no more any obvious approach for further improving scalability. This is mostly because the parallelism in VAR is of rather low level (inside the model loops, inside the obs operators, inside pieces of the transforms and change of variable) while there are several necessary synchronization steps intrinsic to VAR (collection of elements of the gradient, of control vector, steps of transpositions). Several areas exist where some improvement still can be gained: load balancing in the physics, Fast Legendre Transforms (though these presently actually slow down scalability – some adaptation is needed). The observation-related code is the most scalable (computation of H(X) model equivalents, calls to the obs operators).

Otherwise, the potential of the future massively parallel scalar platforms is expected to be exploited thanks to the heavier computational burden of the long window weak constraint 4D-VAR, when all chunks inside the assimilation window would be parallelized. Scalability also could be good for observational computations (I.e., with increasing amount of observations in monitoring and assimilation) and for increasing resolution (but mostly only as concerns the low level parallelism within gridpoint and

spectral computations – there will remain necessary synchronization steps in SL communications or transpositions, for instance). Another possible target is the combination of an ensemble filter approach with VAR.

In the latter spirit, Mats has started to develop an EnKF system (one EnSRF version, one LETKF version), in collaboration with Lars Isaksen and Massimo Bonavita. It uses the IFS first trajectory + QC configuration for computing the departures for each member. The remaining code presently is new Fortran 2003 code including the basic ingredients of an EnKF according to state of the art: computation of a B matrix from the ensemble elements, localization, inflation. This code is now technically working. One important step then will be to start validating the system with real observations. One experimental setup will consist in running a reanalysis benchmark that assimilates only mean sea level pressure values over several decades from the 1930s to the present time.

Concerning VAR, MF asked whether more parallel minimization algorithms could help improving the scalability (anything like solving the minimization locally, and performing global recovering from time to time). Mike says that he is dubious whether such algorithms would be efficient, and the gain in parallelization could not be significant. Mike and Yannick, while visiting Météo-France and CERFACS later this year will discuss minimization algorithms with Serge Gratton, in particular local decomposition methods.

MF and ECMWF agree that the general question of optimization in IFS/Arpège should be regularly addressed during the coordination meetings. MF now has about 1 to 2 EFT affected to optimization issues.

8. AOB

- for information: work is in progress between George Mozdzyński and Antoinette Alias (Arpège-Climate team) for pruning code in the old ECMWF radiation scheme FMR. Arpège-Climate still uses a copy-pasted version called FMR15 as radiation scheme in its reference validation version. Therefore, a careful check between pruning FMR and preserving FMR15 is needed.
- MF asks whether ECMWF could send the code and any related documentation concerning the FDB file system. Mats says that FDB is a piece of code which is only changing when the computer platform changes, meaning also that the concept behind has been coded in a very machine-depending way. MF would like to study the code and understand if the principles in it could be helpful for improving the I/O performances of operations on the NEC/SX9.
- MF would like to test video-conference facilities with ECMWF, as this would improve the communication for coordination meetings as well as for the foreseen technical meetings around OOPS. ECMWF is checking what is feasible. One at least initial solution could be to try to connect a simple internet solution (Skype) with one of MF's video-conference systems. Questions of compatibility and IT security (at MF) will have to be addressed.

9. Date and Place of Next Meeting

Physical coordination meeting in Toulouse, on June 24 2010.

Next phone calls only after the summer then. Maybe extra phone calls for OOPS discussions in between.

List of actions:

1. IPR for ECMWF software and IFS/Arpège source code agreement: action held on & awaiting further discussions between ECMWF and MF at management level.
2. ECMWF will write a short note about how to properly add new fields in the GOM arrays
3. Changes in the ODB tables and descriptors in link with the archiving of ODB in MARS: MF shall check internally for comments and possible further questions or suggestions towards ECMWF => to be further checked between ECMWF and MF (Anne and Dominique Puech); action to be processed promptly
4. ECMWF will send MF a test program for reading/writing grib files (for performance evaluation of GRIB_API on NEC/SX9). ECMWF shall send MF any further information about vector optimization for sbyte/gbyte.
5. ECMWF shall send MF a new version of the OO toy program, so that MF staff can start getting familiar with this code, and possibly “play” with it.
6. MF will prepare an updated version of the Fortran code coding guidelines (in preparation to OOPS)
7. ECMWF will prepare C++ coding guidelines in preparation for OOPS
8. MF also indicates that it would be interested by repeating in Toulouse the OOPS training session planned at the Centre. The proposal is that one or two ECMWF staff can come to Toulouse in order to give the tutorials for MF (and possibly some Aladin/Hirlam) staff. Claude and Jean-Noël shall check how to organize this (including the most suitable dates).
9. Jean-Noël and Claude shall liaise and further adjust the initial managerial OOPS documentation to the expected requirements (task description, GANTT chart), for the next coordination meeting in Toulouse.
10. ECMWF should send MF the code and any documentation on FDB
11. MF should check whether cheap video-conf solutions (of the type of Skype) can be compatible and accessible for its video-conf systems. Alternatively, MF should check whether it can install a cheap solution, symmetric to what would be tested by ECMWF. Keep contacts between MF and ECMWF on this issue.