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: RD14-xxx

Subject: Minutes of the IFS/Arpège coordination meeting – in view of Cycle 42 - held on 2 June 2014.

Participants:

Météo-France: François Bouyssel, Claude Fischer, Ryad El Khatib, Stéphane Martinez, Mylène Civiate, Philippe Chambon

afternoon: Alain Joly, Philippe Marguinaud, Ludovic Auger

ECMWF: Steve English, Deborah Salmond, Peter Lean

ALADIN: Piet Termonia

HIRLAM: Ulf Andrae

Note: the meeting takes place within a period with several other coordination meetings or workshops: visit by P. Smolarkiewicz and C. Kühnlein to MF in order to present the PantaRhei project (5 March), the Scalability workshop (Reading, April), OOPS Steering Committee (Toulouse, 3 June), COPE meeting (Toulouse, 2 June)

1. Adoption of Agenda

The agenda was adopted.

2. Approval of Minutes of meeting of 18 March 2014

Approved.

3. Review of list of actions from last meeting

1. *about COPE: (1) MF and Hirlam to send feedback to EC/FD about the Project Initiation Document; (2) EC, MF and Hirlam COPE contacts to agree on arranging a technical video-conference before the next IFS/Arpège coordination meeting (June 2). => A COPE meeting is taking place in Toulouse at the same time as this coordination meeting. Action closed.*

2. *about model variables encapsulation in CY41: (1) MF to send code examples and Python script to EC (Etienne Arbogast); (2) EC to provide feedback about MF's suggested adaptations for encapsulation (Allocates, Namelists); (3) by the May 13 video-conference, agree on strategy and Python script; (4) at the May 13 video-conference, agree on list of modules to encapsulate. => exchange of codes and scripts between EC and MF. MF have tested implementation and performance of the ASSOCIATE statement on BULL. Action closed.*

3. *about norm checker: (1) Ulf to send Hirlam changes to EC (Paul Burton and Deborah); (2) EC to upgrade their norm checker version for F2008 + Hirlam (Paul), and send new version to MF (Ryad, Stéphane) and Hirlam (Ulf). => the technical specifications will require more liaison between contact persons, as it is felt more attention should be paid to cases where the norm_checker is being used while embedded in a host system, like the compile system (GMKPACK, etc.). It is decided that (1) MF and Hirlam will liaise and agree on a common update, then (2) updated norm_checker is sent to EC. Action on MF (Ryad), Hirlam (Ulf & Rymvidas), later EC (Deborah and Paul Burton). Ongoing.*

4. Progress with CY41

Note: Claude did send the minutes from the 13 May technical video-conference before the coord meeting. Various technical decisions for the build of CY41 were taken at this video-conference.

Deborah presented the status of cycle implementation at EC: besides CY40R1, EC have implemented a CY40R1C including the necessary porting changes for CRAY. CY40R1C is now in pre-operational testing on the CRAY – while CY40R1 is still operational on the IBM. OOPS changes had been introduced in a technical cycle CY40R2, and new scientific contributions are now being added to make CY40R3 which will become the next operational cycle after CY40R1. CY40R3 eventually was more difficult to build than an average scientific cycle, because many branches of contributors had not yet been updated to CY40R2/OOPS changes. Furthermore, it was

recalled that CY40R3 was not included in CY41, and will require an extra phasing in September (CY41R1).

The build of CY41 had been decided to take place in two stages: CY41_V1 to merge CY40T1 (MF+LAM partners) and CY40R2. This merge took place from end of March through mid-May at MF and was felt rather smooth. The pre-phasing efforts by Karim at MF and the preparation in the technical video-conferences probably helped with this respect. Aladin phasers had been invited to MF and greatly helped adapting the LAM codes as well as specific features for Arpège (eg. simplified physics for TL/AD). CY41_V1 was sent to EC on May 22. Next steps are (1) encapsulation of model variables for OOPS + re-factor spectral fields, (2) send back CY41_V2 to MF by 15 June for an extra validation and update (last step of phasing of Arpège and LAM codes + encapsulation of LAM model variables). Eventually, CY41_V2 + final changes by MF would be sent to EC beginning of July for a final check and declaration.

5. Progress and plans at EC

Steve presented the scientific progress and plans related to the recent IFS Cycles.

CY40R3: T255 inner loop in all trajectories, observation error retuning, surface climate fields, aerosol/CO2/O3 climatology, lake model, use of ASCAT and SMOS in SEKF. Capability for assimilating radiosondes and SYNOP in BUFR; COPE screening (not yet continuous) for conventional observations.

Data assimilation related upgrades in more details:

Upgrade of inner loops:

- 255Linear-255Linear-255Cubic (255LLC) grid or 255LLL
- First inner loop iterations reduced from 70 to ~28 (by turning off the randomization method and using identical convergence criteria as in later inner loops)
- First inner loop uses full instead of simplified linear physics (identical to later inner loops)
- Revision of TL/AD (surface coupling, convection)

DA: EDA background error estimation

- Improved EDA noise filtering based on 25 EDA members
- Change calculation of B from using EDA samples from last 12 days to using a mixture of perturbations from last cycle (1/3) and other times of year (2/3). Variance calculation is unchanged based on last cycle.

DA/SAT: Observation error retuning

- Stage 1: conventional observations with clearly wrong observation errors (stage 2 will be later: Improved consistency across all observation types)

DA/SAT: Conventional and Satellite observation changes

- RTTOV-11 (scientifically neutral at 40r2; at 40r3 activate scientific improvements)
- All-sky assimilation upgrade (MHS moved from clear to all-sky; SSMIS 183 GHz channels over land and sea-ice; azimuthal dependency of surface emissivity; GMI readiness….AMSR2 activation on hold)
- Assimilation of surface-sensitive ATMS channels over land and modified emissivity Kalman filter atlas and bug-fix for skin temperature sink variable for radiances (in 40r2)
- Assimilation of GPS-RO with 2D operator and assimilation of ground based GPS
- High-resolution radiosondes, aircraft humidity and re-introduction of ascent/descent dependent aircraft temperature bias correction
- Observation based FEC in operational monitoring

Model changes:

- Cloud scheme (change of rain evaporation, auto-conversion/accretion, riming, precipitation fraction, improved representation of supercooled "freezing" rain, Modified convective detrainment)
- Activation of lake model (FLAKE – a 2 layer lake model)
- Improved SL-trajectory (stratospheric noise – important for SSWs)
- 1st set of new surface climate fields (land-sea mask, sub-grid orography)
- MACC-II CO2/O3/CH4 climatologies; bug fix for CO2 increase

EC had tested separately the impact of the model changes, the satellite changes and the DA changes in CY40R3. Those were found to be mostly positive (more details, see slides). At present, work is ongoing for assessing the impact of all changes when added together.

Plans for 2014/2015 then reads:

- **CY41r1:** Increase horizontal resolution for HRES(T2047), EDA (T511), 4D-Var (T255 Cubic)*, ¼ deg for ocean model in ENS, COPE
- **CY42r1:** Increase of ENS horizontal resolution (T1023), OOPS

In the discussion, EC confirmed they had switched off the weak-constraint 4D-VAR term in the stratosphere as this created spurious errors bred within the assimilation cycle, at high levels. MF asked about details on the changes in the SL trajectory computations, in link with

problems seen in the model's stratosphere. EC will send information to MF (action). As a post-meeting note: the *cubic grid* definition is that the model is run with a Gaussian grid corresponding to double the spectral truncation equivalent linear grid: eg. for a spectral T255 (for semi-implicit computations), the cubic grid is equivalent to T511 for the model grid-point computations.

6. Progress and plans at MF

François presented the preparations for the forthcoming high resolution E-suites at MF: Arpège T1198C2.2L105 and Arome-1.3kmL90.

The very first E-suite on BULL however will be a technical suite for implementing the I/O server and updating the use of observations in the production run assimilations to the same level as in the assimilation cycle of Arpège. This suite will run with CY38T1.

For the high resolution E-suites, MF will move to a CY40_op1. In addition to the increase of horizontal and vertical resolution, the settings of the 4D-VAR two outer loops will be changed: 1st minimization with T149c1L105 (~135km) with 40 iterations (instead of T107c1L70 with 25 it) and 2nd minimization with T399c1L105 (~50km) with 40 iterations (instead of T323c1L70 with 30 it) . The times slots should be changed from 1h to 30' width. Some satellite radiances will have increased density in assimilation (especially for microwave). The Arpège ensemble DA will be upgraded to using 25 members at T479L105 and the Arpège EPS system will have increased resolution as well (T798C2.4L90) while keeping 35 members.

An important aspect on the model side will be the implementation of a new global convection scheme (PCMT) along with an improved turbulence scheme (PMMC09) for thermals.

In Arome-1.3km, the local flow dependent SL interpolation (so-called “COMAD”) will be evaluated. COMAD had been introduced in the common codes as a collaboration between MF and EC. Among other changes in the model settings, the Predictor/Corrector scheme will be switched on (it is at present off for Arome-2.5km) and the time-step is decreased from 60s to 45s. In assimilation, an hourly 3D-VAR cycle will be implemented along with an Incremental Analysis Update for optimizing the inclusion of the most recent high frequency analysis in the Arome production forecast.

In parallel, and with a view for implementation in 2015 and 2016 resp., new Arome applications are being tested: Arome-Nowcasting, Arome-EPS.

MF pointed out that they would face a difficult period in 2015, with a much reduced capacity of NWP experimentation and probably development (and debugging). This period is when the Phase 1 operational BULL cluster (“prolix”) will be switched off and dismantled, in order to construct the first of two Phase 2 BULL clusters. This is expected to take place over August-September-October 2015.

The reader is referred to François's slides for more details (available on demand).

Claude presented an overview about the progress and plans with pre-operational and R&D cycles (CY40_op1, CY40T1, CY41, expected CY41T1 in the autumn/winter 2014/2015). EC asked about the pruning of SAMIO in the code, while they had information that FMI were still using it in their Harmonie system. Ulf confirmed SAMIO had been removed by the Hirlam System group as a contribution to CY40T1. EC further asked about more information on the code normalization features introduced by Hirlam (work by Rimvydas Jasinkas from Lithuania), as the specific technical justification wasn't always straightforward. Also, at specific places, some changes were causing problems for the CRAY compiler (promotion of variables with _JPRB).

Action: Ulf to liaise with Deborah, and Ryad in copy, and send information about Rimvydas' changes for CY41 (precise list, documentation and explanation about the technical motivation).

7. HIRLAM comments

Ulf explained HIRLAM were finalizing their CY38H1.2, which is an evolved version of CY38T1. Contributions to this cycle are candidates for the common codes for CY41T1. Specific attention is being paid to the code re-factoring for data assimilation (OOPS) and porting to new computer architectures (MIC). Ulf mentioned that one staff at met.no has suggested a new F2003 feature for the SURFEX code. Although this is not IFS code per se, this item should be addressed in a technical coordination meeting as SURFEX is distributed along with Arome/Harmonie/IFS codes to all ALADIN and HIRLAM partners. See also item 9.1 below.

8. ALADIN comments

ALADIN countries are presently implementing CY38T1. On the side of code developments, ALADIN staff had been active on the design and coding of a new physics/dynamics interface for Arpège and LAM models (RMI/D. Degrauwe, this code is now in CY40T1 and CY41), and ALARO physics upgrades. They expected to become more directly involved in COPE very soon (LACE contact: Alena Trojakova from CHMI).

9. Specific items for discussion

9.1. Update on recommended compiler versions, F2003, F2008, C++ requirements, for installing the IFS/Arpège/LAM codes

The specifications for Fortran/C++ language levels and related libraries are important for portability of the IFS/Arpège/LAM codes on various platforms, and preparations of benchmarks. Furthermore, new coding features of F2003 or even F2008 may not be supported by all compilers. EC confirmed that they had no

plans to propose new F2003 features for the IFS for the time being, and they wished the codes to keep a high level of portability. Also, COARRAYS (F2008) were not planned to enter the IFS official code at this stage as they are only available on CRAY and do not give significant speed-up on the numbers of tasks we are using for operations and research. Deborah mentioned that EC had interest to study alternative solutions to, for instance COARRAYS, and were interested to collaborate closer with MF on this (contact is Philippe Marguinaud). HIRLAM recalled that they had received a proposal by a met.no staff for a new F2003 feature for SURFEX. MF also potentially had a new feature from F2003 to propose (allow POINTER to FUNCTION).

There is a consensus to keep introducing F2003 features in a very limited and controlled manner. Proposals will be discussed and checked with all partners.

Actions: HIRLAM (Ulf) to send the F2003/SURFEX proposed feature to others (MF, EC), MF (Philippe/Ryad) to send the example of POINTER to FUNCTION to others. For all: check proposals (including all LAM partners) before decision-making w/r to the list of IFS/Arpège/LAM permitted F2003 features.

Another action is to update the recommendations about Fortran/C++/Boost standards for benchmarking and call for tender specifications => Deborah and Claude.

9.2. exchange of new computer news BULL, CRAY etc. and migration/optimisation work we have done on both sides

Ryad presented the algorithmic code optimizations performed over the last year: finalization of Full-POS2, parallelization of FESTAT, development of a Post-Processing server, optimization in FA/LFI Arpège file format, recode of the matrix dilatation/contraction codes for Arpège stretched grids. Philippe introduced the I/O server, which will be tested pre-operationally in the forthcoming Arpège E-suite. Deborah gave a status report about the efforts at EC for porting the IFS on CRAY. They found that the CRAY compiler initially had several problems affecting IFS (forecast and 4D-Var) – these had now been fixed by CRAY in their latest release. EC compile with rather conservative options on the CRAY (as they did on IBM) to ensure bit-reproducibility and good adjoint test results. On the whole, the needed work for porting turned out to be more important than expected. Important changes had also to be done on the scripts, and it is planned to later change the job-submission software (still PREPIFS/SMS for the time being, to be replaced by ECFLOW).

Alain asked about performance aspects of 4D-VAR on CRAY, and how the use of the cubic grid was improving the performances (as said at the Scalability workshop in April). Action: EC (Deborah) to send information about the principle of the cubic grid approach, along with performance figures on CRAY.

9.3. preparation for the assimilation of Megha-Tropiques/SAPHIR observations at MF

Philippe Chambon presented the work at MF in preparation for the assimilation of SAPHIR data in Arpège 4D-VAR. Steve commented on the shown error biases, which were decreasing for increasingly low-peaking channels. This behaviour might be a signal of undetected clouds

9.4. plans for ODB (and ODB_API) at ECMWF

Peter Lean presented the plans of evolution for the ODB. In the short-term, it is planned to simplify the calling interfaces from the IFS (GETDB/PUTDB). The simplified interfaces could be ready for CY42. In the longer term, a unification of ODB-1 and ODB-API (formerly also known as ODB-2) is expected, followed by an implementation of ODB-API in IFS. The question was raised whether OBSTAT would use ODB-API rather soon, or whether/when this move is planned.

During the meeting, the ODB governance at ECMWF was recalled. The governance is in charge of surveying and harmonizing the various requests for changes in the ODB (new tables, new columns etc.). Peter is the coordinator of the governance. MF and the LAM partners are supposed to streamline their questions and requests for ODB via specific contact persons. For MF and ALADIN, these are Dominique Puech and Alena Trojakova (alena.trojakova@chmi.cz). For HIRLAM, the contacts were not yet clear, as there had been changes in staffing.

Actions: Peter Lean to check about the status of OBSTAT and ODB (ODB-1 or ODB-API) and possible plans for porting OBSTAT to ODB-API. Ulf to check and provide the names of the ODB contact persons for HIRLAM (2).

10. Content and timing of CY42

Deborah presented the re-factoring items expected in the IFS Fortran code for CY42:

- Model derived types passed through argument lists (rather than used from modules)
- COBSALL (single call)
- STEPO, STEPOTL & STEPOAD : no more STEPO_OOPS
- JB, TOVSCV and change of variable
- Varbc linked to OOPS + clean-up
- Other Observation types
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The next technical target for code re-factoring was to enable running a single resolution IFS multiple outer loops 4D-VAR from OOPS with CY42.

Claude mentioned that MF and the LAM partners might implement new predictors in the Varbc code for ground-based GNSS/GPS data. A cross-check with the foreseen changes by EC (A. Geer and Y. Trémolet) might be good. Action: EC to send information about the Varbc re-factoring to MF. If required, plan an item for discussion on Varbc recoding or extension of flexibility at a forthcoming technical video-conference.

Our rolling Table of planning, regularly updated !

Joint cycle	ECMWF	MF	Start pre-φ	Declaration	Misc. / Oper plans
CY40			March 2013	July 2013	
	CY40R1			Oct 2013	Oper in Feb 2014
	CY40R2			Feb 2014	Technical cycle including many OOPS & refactoring features
		CY40T1	Dec 2013	Feb 2014	
	CY40R3			1 July 2014	Handover to OD/FD end of July 2014
CY41			End of March 2014	July 2014	Merge of CY40T1 and CY40R2
	CY41R1			Sept 2014	Merge of CY40R3 and CY41
	CY41R2		Deadline for changes:Nov 2014	Dec 2014	Scientific and OOPS technical changes incl.
	CY41R3				To be confirmed
		CY41T1	End of Nov 2014 = deadline for contributions	February 2015	Build this cycle (phasing) over Dec 2014 – February 2015
CY42				March-June 2015	
	CY42R1				Implement OOPS

11. AOB

Ryad asked about the status of scientific validation of Full-POS2 at EC. Deborah mentioned they still faced issues for the EPS outputs in the upper atmosphere, but no more near the surface. Deborah and Ryad will stay in contact about these aspects.

12. Next meetings

Next technical video-conferences:

- Tuesday 26 August, 1.30pm UK / 14h30 MEST

Next Coordination video conferences:

- Thursday 13 November 2014, 1.30pm UK / 14h30 MEST
- another video-conference would take place in February, date to be discussed later

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

List of actions

1 *update of norm_checker (based on Hirlam input): the technical specifications will require more liaison between contact persons, as it is felt more attention should be paid to cases where the norm_checker is being used while embedded in a host system, like the compile system (GMKPACK, etc.). It is decided that (1) MF and Hirlam will liaise and agree on a common update, then (2) updated norm_checker is sent to EC. Action on MF (Ryad), Hirlam (Ulf & Rymvidas), later EC (Deborah and Paul Burton).*

2 *EC to send information about the Varbc re-factoring to MF, ALADIN and HIRLAM. If required, plan an item for discussion on Varbc recoding or extension of flexibility at a forthcoming technical video-conference.*

3 *EC to send information about the changes in the SL trajectory computation, in link with noise seen in the model's stratosphere.*

4 *About code normalization features implemented in CY41 (via CY40T1): Ulf to liaise with Deborah, and Ryad in copy, and send information about Rimvydas' changes (precise list, documentation and explanation about the technical motivation).*

5 *ODB:*

5.1 Peter to check about the status of OBSTAT and ODB (ODB-1 or ODB-API) and potential plans for porting OBSTAT to ODB-API.

5.2 Ulf to check and provide the names of the ODB contact persons for HIRLAM (2).

6 *F2003/C++: HIRLAM (Ulf) to send the F2003/SURFEX proposed feature to others (MF, EC), MF (Philippe/Ryad) to send the example of POINTER to FUNCTION to others. For all: check proposals (including all LAM partners) before decision-making w/r to the list of IFS/Arpège/LAM permitted F2003 features.*

7 *Update the recommendations about Fortran/C++/Boost standards for benchmarking and call for tender specifications => Deborah and Claude.*

8 *EC (Deborah) to send information about the principle of the cubic grid approach, along with performance figures on CRAY.*