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: RD13-xxx

Subject: Minutes of the IFS/Arpège coordination video-conference – in view of Cycle 41 - held on 9th December 2013.

Participants:

Météo-France: Alain Joly, Claude Fischer, Ryad El Khatib, Karim Yessad, Ludovic Auger, Stéphane Martinez

ECMWF: Jean-Noël Thépaut, Deborah Salmond, Peter Lean

Part time: Piotr Smolarkiewicz (only for item on dynamics)

ALADIN: Piet Termonia (excused)

HIRLAM: Ulf Andrae

0. Adoption of Agenda

The agenda was adopted.

1. Approval of Minutes of meeting of 3rd June 2013

Approved.

2. Review of list of actions from last meeting

1. *When Anne leaves EC in August there needs to be a new contact point for ODB matters at EC. => Peter Lean is going to become the new person in charge of ODB in January 2014. Action closed.*

2. *About the overhaul of EC's scripting system and the link with VORTEX: EC will invite Eric Sevault for a 2 day visit in Reading. MF and EC will liaise and check about appropriate dates with Eric. => Eric not being able to travel to Reading in early summer this year, Willem Deconinck visited MF instead and had discussions with him. Action closed.*
3. *MF will try to run COPE and provide feedback to EC. Also the impact of removal of code types in COPE needs to be checked by MF => MF will further check whether some parts of COPE code can be run now on BULL or PC. This action remains open. The removal of code types had been discussed before Anne left ECMWF, and adaptations had been prepared for Bator. This action is closed.*
4. *Add the list of actions from the COPE meeting to these minutes for tracking by the IFS/Arpège Coordination group => Closed.*

Actions from COPE video-conf

1. *ECMWF to make available in COPE git repository the "re-factored" BUFR2ODB => Done. Action closed.*

2. *Meteo-France/HIRLAM/ECMWF to make an extensive and detailed list of all the COPE filters we need to implement. The list must be available on COPE JIRA at https://software.ecmwf.int/wiki/display/COPE/COPE+filters => MF has sent its contribution. Hirlam input is expected to compete MF's. ECMWF contribution remains to be sent. MF had expressed interest on receiving simple examples of C++ filter programs (as templates) from ECMWF. Action open.*

3. *Set-up a video-conference in Autumn to dispatch the work between the participants. => Done. Action closed*

New action about COPE: EC and MF coordination contacts will approach their COPE teams, and ask that a status report + list of action is provided for the forthcoming COPE video-conferences. This more formal exchange of information will ease the monitoring of progress at coordination meetings.

3. Progress and Plans of ECMWF

Jean-Noël gave a detailed overview of EC's progress, in link with new IFS cycles. The overall evolution for the IFS is the following:

- **CY38r2**: L137 for EDA/4DV/HRES, modifications of physical parameterizations
- **CY39r1/40r1**: L91 for ENS, day-0 coupling with updated ocean, 25 EDA members, online B, boundary layer, convection, SSMIS/AMSU-A, bg-errors in radiance-space

- **CY40r2(3)**: 24-hour 4DV, T399 inner loop, observation error retuning, surface climate fields, aerosol/CO2/O3 climatology, lake model, use of ASCAT and SMOS in SEKF
- **CY41r1:** Increase horizontal resolution for HRES(T2047), EDA (T511), 4D-Var (T2047/T399), ¼ deg for ocean model in ENS, COPE
- **CY42r1:** Increase of ENS horizontal resolution (T1023), OOPS

In more details, per IFS cycle:

CY39R1/CY40R1:

ENS: Increase of number of vertical levels from 62 to 91 in ENS (also relevant for MOFC); Atmosphere-ocean coupling of ENS from day-0 (new NEMO version; NEMO tendencies added to OSTIA analysis, then relaxed to full NEMO b/w day-5 and day-9); Initial perturbations from 25-member EDA; Perturbation of land surface initial conditions

EDA: On-line estimation of background errors, using 25 EDA members; Perturbation of land surface temperature and moisture observations
HRES: CAPE release to address diurnal cycle of convective precipitation; Vertical diffusion and orographic GWD; Consistent snow albedo between radiation and land-surface scheme - Jean-Jacques
4DVAR: Retuning of the regularization of upper-air and surface exchange coefficients in the TL and AD versions of the simplified vertical diffusion scheme; All-sky microwave: SSMIS 183 GHz channels activated; discrete dipole snow scattering; Enhanced use of AMSU-A/B/MHS data over sea-ice ; Use of calibrated EDA spread in radiance space as background error estimate for the ATOVS FG-check; Situation-dependent observation errors and revised QC for AMVs; Variation of refractivity between model levels above 10 km consistent with a linear variation of temperature with height ; Imager-assisted cloud detection for IASI radiance data
WAM: Changes to shallow water calculation and surface air density

MACC: Aerosols: post-processing of Aerosol Optical Depth ; Updates to the Calipso lidar observation operator. Updates to the MODIS AOD VarBC; Observation operators for GOSAT CO2 and CH4 retrievals. Coupling with CTESSEL; Inclusion of C-IFS in data assimilation ; Changes to allow fast-response experiments in case of volcanic eruptions

Technical:

- ECFLOW python suite definition for data assimilation
- Revision of CALLPAR
- Revision of small planet formulation in physics
- Generic approach to get the most recent input file for a given cycle in snow blacklist
- SSMIS radiance monitoring over land
- Wave model Charnock parameter used in minimization
- NH and shallow water model (and miscellaneous) bug fixes
- ODB feedback for surface analysis observations
- Quality control for ATMS lunar intrusions

- Move of cloud detection for AMSU-A/B/MHS/MWTS/MWHS from blacklist to IFS-code for dedicated flagging
- Treat NOAA-18 MHS as MHS, not as AMSU-B
- Implementation of new ozone data from MetOp-B GOME-2 (TCO) and NPP OMPS (TCO and nadir profiles)
- Geometry object for OOPS
- OOPS cleaning of JB
- COPE mods for ADM-AEOLUS

CY40R2: = CY40R1 + technical Cray features + OOPS (geometry, model, etc.) + RTTOV-11 + Full-Pos-1 unusable (broken) [about FP1: it's agreed that MF will prune the FP1 code at their earliest convenience]

The scoring charts of CY39R1 with respect to the operational IFS version (CY38R2), against IFS's own analyses, computed over a one year period (June 2012 – June 2013], show overall positive results. The only degradation observed for the time being is for T2m and V10m at short range, and for wind at about 850 hPa in the Tropics.

Other specific EC targets for the coming months included:

- Hard deadline for final migration IBM → Cray: 1 July 2014

- 1st hardware (48 nodes) arrived mid September 2013 for T42 testing
- 1st full Cray cluster RFT mid December 2013 for full testing
- OD T1279 testing planned for late December 2013/January 2014
- March/June switch off of IBM clusters, IBM primary / Cray back-up until then
- 40r1 instead of 39r1 will be implemented on IBM in November, and migrated to Cray
- Next scientific cycle will be CY40r3

4. Progress and Plans of Météo-France

Claude gave an overview of the recent activity on the NEC and BULL NWP suites:

- the last scientific E-suite tested on NEC was switched to operations on July 2, 2013 (CY38T1).

- in July/August, migration of NWP libraries and validation of the NWP suite in the OLIVE scripting environment was performed by GMAP.

- in September, the BULL mirror suite was built. Technical tests and validation extended into October. Various system-related problems had to be addressed, with support by the BULL team.

- A technically stabilized mirror suite was obtained over November. The suite indicated a slight but worrying deterioration of Arpège scores over Europe after 48h forecast range.
- After a stop for hardware upgrade in beginning of December, the mirror suite is now running again. Investigations about the scores obtained in November will be continued. The expected date for the switch to operations on BULL is January 14, 2014.
- scientific studies in preparation of the high resolution suites planned to start in E-suite in 2014, are also ongoing.

ECMWF indicated they had well progressed with porting their applications to the CRAY new HPC, using the provided test machine as support. IFS T511 was fully validated. First technical porting on the target CRAY machine ("cca") has started, and at present problems with GRIB2 handling were being investigated. About 5-6 coding problems were found on CRAY, in the IFS code, but for the time being no compiler problem was noticed.

Action: Deborah will send MF and Hirlam the list of trouble-making pieces of code, and the workarounds were done.

On the side of cycles, a "quick" release CY40_op1 was built in order at MF to start testing bricks of the 2014 high resolution E-suite with CY40 as basis. The major R&D interim cycle is being built right now (CY40T1), including a number of contributions from the LAM partners. The overview list of contents is given below:

CY40_op1.02: built in mid-November 2013. Declared on Nov 14.

Content:

- fixes to run the variational assimilations (Arpège, Arome) in CY40 (L. Raynaud, L.-F. Meunier, P. Brousseau)
- fixes for porting the codes to BULL (from cc-tagged CY38T1_op2.[1-10]) (L.-F. Meunier)
- for emissivity atlases used only in limited area systems (i.e. SEVIRI atlas), migrate the atlas file to a binary format (already tested in cy38t1_op1) (L.-F. Meunier)
- rewrite of the ATMS observation averaging inside Bator (LFM)
- Fix for IO_METHOD=4 in ODB (P. Marguinaud)
- Fix for applying the vertical interpolations for radiances inside RTTOV (instead of pre-calculating them), in the case of CO2-slicing (MF configuration, V. Guidard)
- Fix for wind bogus in Bator (mandatory) and screening (inactive bug), for PAOB obs type (Aladin Overseas configurations) (F. Guillaume and G. Faure)

- HR E-suite changes for the new Arpège convection scheme PCMT and the shallow convection PMMC09 (Y. Bouteloup, J.-M. Piriou)
- FABEC in Full-POS outputs (code for computing flight level parameters) (F. Voitus & R. El Khatib)
- Fix to enable reproducibility of KFB scheme in MPI and Open-MP parallelization (F. Bouyssel)
- Parallelization of the computation of the sea ice mask (F. Taillefer)
- Adaptations for enabling East-West MPI data distribution in DDH (R. El Khatib)
- Fix for Arome in dynamical adaptation and hydrostatic mode (K. Yessad, Y. Seity)
- Enable a flexible choice of the size of the coupling zone by namelist (presently, this parameter is hardcoded and 8 is the default) (F. Voitus)
- Extra fixes for porting (CY38T1_op2.[11-12]): CTPINI configuration (MF only), …

Note: CANARI surface analysis is *not working* in this code version .

CY40T1: code contributions must be ready end of November 2013, for a build of the cycle from December 2013 through February 2014. This cycle will only be handled in MF's GIT repository.

Technical content would include:

- All contributions to CY40_op1.01/02 are repeated for CY40T1
- System/code aspects:
    - removal of command line options (E. Arbogast)
    - specific code cleaning (final part) in LAM LBC code (B. Bochenek, F. Voitus)
    - fixes for SLHD and some minor code cleaning (K. Yessad)
    - optimization of I/O; re-write of LFI package in C; frame option for coupling data (P. Marguinaud)
    - re-write of the IO server; first implementation of a post-processing server (P. Marguinaud)
    - optimization and parallelization of FESTAT for LAM. (R. El Khatib)
    - fixes for CANARI in CY40 (F. Taillefer)
- Full-POS:
    - Fullpos-2 : CPU optimizations and support for Boyd bi-periodization (REK)

    - On-line computation of dilatation/contraction matrices and filtering matrices (for post-processing); optimization of the computation of filtering matrices for Arpège post-processing (REK)

- Observations:
    - Fixes for MF's cloud detection method "CO2-slicing" (V. Guidard)
    - Support for SAPHIR sensor aboard MEGHA-TROPIQUES (L.-F. Meunier)
    - Modified parameters for the geographic mask of winds derived from geostationary satellites, and impact on blacklists (C. Payan) – not confirmed yet -
    - Multi-grid facility for the use of scatterometer winds (C. Payan) – not confirmed yet -
- AROME:
    - Introduction of sub-grid precipitation (S. Riette)
    - Adaptations in "mse" to interface Surfex V7.3+ (Y. Seity, F. Taillefer)
    - Fixes and optimisation in EDKF (S. Riette, Y. Seity)
    - Fixes for hail, cloud sedimentation, coupling with 1D model (Y. Seity)
    - Fix about the post-processing period of wind gusts (F. Bouttier)
    - Flow-dependent SL interpolations (D. Ricard, in collaboration with S. Malardel and GMAP)
    - Optimization in "couplingsurf" task (for restart) (Y. Seity)
- ARPEGE:
    - Developments for the convection scheme PCMT (J.-M. Piriou)
    - Developments for the new shallow convection scheme PMMC09 (Y. Bouteloup)
    - Fix to ensure bit reproducibility of the "old" shallow convection code KFB in distributed memory (F. Bouyssel)
    - Developments for the 1D model MUSC (Y. Bouteloup)
- ALADIN:
    - Vertical Finite Elements code for NH/LAM+global (J. Vivoda, P. Smolikova, K. Yessad)
    - New physics/dynamics interface CPTEND_FLEX (D. Degrauwe, F. Bouyssel, Y. Seity)

    - New radiation code ACRANEB2 (J. Masek, R. Brozkova)
    - Some adjustments in TOUCANS (R. Brozkova)
- HIRLAM:
    - adaptations to improve porting of codes & technical fixes, in particular for the IO server, the assimilation code, for pruning SAMIO (E. Whelan, U. Andrae, others)
    - extended VarBC code for GNSS/GPS ZTD (P. Moll, R. Randriamampianina, M. Lindskog)
    - improvement of code normalization features (R. Jasinkas, U. Andrae, in liaison with MF and ECMWF)
- SURFEX version 7.3++ including:
    - Optimisation in PREP (work by T. Dalkilic & D. Degrauwe with S. Faroux), corresponding to the NEW_PREP branch in the Surfex repository
    - Surface perturbations in Surfex for PEARO (F. Bouttier)
    - surface EKF assimilation code overhaul (SODA, Trygve Aspelien)

5. HIRLAM views and constraints

Ulf indicated that they had started to port the very recent first pre-release of CY40T1 (CY40_t1.01 built on Dec 3-4 in MF). First code checks will start soon (Rimvydas Jasinskas, from Lithuania, among others).

Besides following progress of CY40T1, Hirlam expected to release CY38H1 (=CY38T1 + Hirlam extra changes) in January 2014.

CY41 was felt as an important milestone cycle for getting involved in OOPS, both in terms of preparation of this cycle (phasing) and in terms of porting and testing in OOPS context (prototyping).

6. ALADIN views and constraints

On behalf of Piet and Daan, Claude stressed the importance of a good coordination between various technical changes at the level of the physics/dynamics monitoring routines. Most

importantly, care will be taken to well handle the expected encapsulation of model variables (in view of building a sound Model object for OOPS) and the ongoing re-design of the Arpège/Alaro/Arome interface routines. In principle, the first evaluations by Claude and Daan suggested that these changes would be rather orthogonal technically speaking. But their sequence of implementation will require re-phasing (probably by the Aladin staff involved in the re-design). Claude also pointed out that a first, important part of the physics/dynamics re-design entered CY40T1 as an optional new code within MF_PHYS.

7. Timing of CY41 and CY42

As a specific topic, the re-factoring of the Model object code in the IFS was addressed. ECMWF propose to perform a quasi-automatic encapsulation of the global model variables by the means of a Python script. The script would (1) encapsulate model variables in MODULEs into derived types and (2) implement ASSOCIATEs statement to create aliases between the encapsulated and the local variables in compute routines (this second step in order not to overload the code with STRUCT%VAR sequences and keep the code readable for the scientists). The script should work on individual development branches, so that any scientist could re-factor his development code. It is believed that the whole re-factoring work would take about 1 week time, including compilation and simple tests. The proposal by ECMWF is to implement this encapsulation for CY41 in about June/July 2014. As a follow-on step then, the derived types will have to be passed as arguments throughout the Model Fortran calling sequences. This work was expected for CY42, and would be manual.

MF insisted on the need to well understand how deep in the code this re-factoring would dive, and make sure there is no drop of numerical performance due to the re-factoring (is the ASSOCIATE statement handled the same way by all compilers ?). The following actions were decided: (a) EC will send a preliminary list of IFS routines and modules that would be affected by the re-factoring, (b) MF and LAM partners will complete it with their own list, (c) wrap-up at the next video-conference (Jan 27), (d) ECMWF will develop the Python script in January, (e) application of the script on local versions, tests of compilation and model execution including performance, (f) wrap-up (Feb 20). A firm decision for implementation is expected at the next coordination video-conference (March 18).

The table which merges the plans for cycling of IFS by MF and EC was updated. It was acknowledged that this summary table had proved to be useful for planning.

Joint cycle	ECMWF	MF	Start pre-φ	Declaration	Misc. / Oper plans
CY40			March 2013	End of June 2013 at the latest	
	CY40R1			Oct 2013	Oper in Feb 2014
	CY40R2			Feb 2014	Technical cycle including many OOPS &

					refactoring features
		CY40T1	Dec 2013	Feb 2014	
	CY40R3			March 2014 (RD)	Handover to OD/FD in May 2014
CY41			Between March 17 and April 3 2014	June 2014	Merge of CY40T1 and CY40R2
	CY41R1			Sept 2014 (RD)	Handover to OD/FD in Dec 2014; migration to COPE
		CY41T1	Dec 2014 ?		
CY42				April 2015 ? (1)	
	CY42R1				Implement OOPS

(1) MF has suggested a back-up scenario with a fairly late declaration by July 2015 to take into account the period of one single BULL – C2 – cluster available. This schedule should be further addressed in future coord meetings.

8. Plan for Numerics at ECMWF

Piotr Smolarkiewicz gave an introduction to the PantaRhei project (see Appendix). For end of 2014, the goal was to have a fully 3D non-hydrostatic (NH) flexible-mesh solver that works on the IFS grid. For the end of the project (2018), the goal was to have a handy robust NH configuration that works on future high performance computers.

Alain Joly asked how these goals would fit into the IFS code evolution, with respect to the other system components like data assimilation, physics etc. Indeed, there exist many common coding features or assumptions spanning throughout the IFS components. Piotr explained that the idea rather would be to marry two codes, one being the hydrostatic IFS and the other being a new NH EULAG-type code. Jean-Noël pointed out that code architecture should be part of the discussion, for instance in the planned visit by Piotr to MF.

Action: find a suitable date and plan the visit by Piotr S. And Christoph Kühnlein to MF, presumably in February or March (one or two days visit). Claude shall inform Piet Termonia for a possible participation of Aladin staff.

9. ODB + COPE

Peter Lean was introduced to the participants of the meeting. He's going to take over the development and maintenance of ODB from January 2014 onwards. He would become the contact person about ODB for MF and the LAM partners from March. We will use an opportunity of one of the forthcoming video-conferences for introducing him to MF's contact,

Dominique Puech. Peter was previously working in the Satellite Section and already has a background on the preparation of observational data for NWP.

Claude explained that most likely, the first concrete opportunity for a direct liaison between MF and EC contacts would be the preparation of CY41, as several small changes had been implemented in CY40T1.

10. AOB

none.

11. Date and Place of Next Meeting

Next technical video-conferences:

- Monday 27 January 2014 (1.30pm UK / 14h30 CET): address list of routines/modules that will be affected by Model object re-factoring
- Thursday 20 February (same time): feedback about applying the Python to the model code, and tests of performances

Next Coordination video conferences:

Tuesday 18 March (same)

Next Coordination Meeting in Toulouse: first week of June 2014

12. List of Actions

1 *about COPE:*

1.1 *MF will try to run COPE and provide feedback to EC.*

1.2 *Meteo-France/HIRLAM/ECMWF to make an extensive and detailed list of all the COPE filters we need to implement. The list must be available on COPE JIRA at https://software.ecmwf.int/wiki/display/COPE/COPE+filters => MF has sent its contribution. Hirlam input is expected to compete MF's. ECMWF contribution remains to be sent. MF had expressed interest on receiving simple examples of C++ filter programs (as templates) from ECMWF.*

1.3 *EC and MF coordination contacts will approach their COPE*

teams, and ask that a status report + list of action is provided for the forthcoming COPE video-conferences.

2 *ECMWF porting to CRAY: Deborah will send MF and Hirlam the list of trouble-making pieces of code, and the workarounds were done.*

3 *Plans for numerics at ECMWF: find a suitable date and plan the visit by Piotr S. And Christoph Kühnlein to MF, presumably in February or March (one or two days visit). Claude shall inform Piet Termonia for a possible participation of Aladin staff.*

4 *Model object re-factoring (Python script, ASSOCIATE): (a) EC will send a preliminary list of IFS routines and modules that wold be affected by the re-factoring, (b) MF and LAM partners will complete it with their own list, (c) wrap-up at the next video-conference (Jan 27), (d) ECMWF will develop the Python script in January, (e) application of the script on local versions, tests of compilation and model execution including performance, (f) wrap-up (Feb 20). A firm decision for implementation is expected at the next coordination video-conference (March 18).*

Appendix: introduction to the PantaRhei project by Piotr Smolarkiewicz

Interdisciplinary Integrated Forecasting System for Fluid Flows (PantaRhei)

Ultimate Goal: Development of a high performance modeling system for simulating multi-scale fluid flows with unprecedented range of multidisciplinary physical applications.

NWP/Climate aspect: Development of an approach extending skills of established NWP models to globally nonhydrostatic resolutions while benefitting from their hydrostatic expertise.

Technical aspect: Developing massively-parallel control-volume integrators for all-scale (nonhydrostatic) compressible, soundproof and unified (Arakawa-Konor) PDEs, operating on flexible meshes

Current State: Global massively-parallel shallow-water control-volume solver on arbitrary meshes (including control volumes built around IFS's reduced Gaussian grid) and a newly developed numerical framework for (explicit and semi-implicit) consistent integrations of soundproof and compressible equations of atmospheric dynamics. (CRESTA + PantaRhei: Deconinck, Hamrud, Smolarkiewicz, Kuehnlein, Wedi)

Plans for 2014: To have by the end of 2014 a fully 3D nonhydrostatic flexible-mesh solver capable to work on the IFS grid and exchange fields of dependent variables without interpolation. To have AK unified system working in IFS (Kuehnlein) and, possibly, in PantaRhei (Kuehnlein, Smolarkiewicz, Wedi)

Technical basis: The key technology are EULAG's numerical procedures expressed in time-dependent generalized curvilinear coordinates, allowing for pairing the mathematical apparatus underlying IFS and EULAG. A second key technology are newly developed data structures ultimately available as an auxiliary library to facilitate the efficient (and parallel) use of arbitrary meshes.

5 year plan: Integrate the new model with IFS to realize ECMWF's long term strategy by efficiently using the emerging future computing architectures and by providing one of the most advanced computing tools available to the European community (through the Open IFS project) for research and education.