ALADIN/HIRLAM/LACE
Rolling Work Plan 2018

V.29 Nov. 2017 approved by GA/C

Contents

Introduction

Since 2005, the ALADIN, LACE and HIRLAM consortia have been cooperating closely on the development of a common limited area model code within the framework of the IFS/Arpege code system. The cooperation takes the form of joint scientific and technical model developments within this so-called shared ALADIN-HIRLAM System. Research and development efforts focus on three so-called canonical model configurations (CMC's) which together make up the shared A-H System: Arome-France, Alaro-Cz and Harmonie-Arome. It is these canonical model configurations which are defined and validated with specific sanity checks from cycle to cycle, and for which support within the consortia for users is guaranteed. For Harmonie-Arome, several practical steps are being undertaken still before it can be fully recognized as a CMC, following the roadmap that has been made for the ALADIN-HIRLAM convergence process.

The activities within the ALADIN-HIRLAM-LACE cooperation are described in a yearly jointly produced rolling work plan. This document represents the joint ALADIN-HIRLAM-LACE rolling work plan (RWP) for 2018. The main aim of the RWP is to provide clarity on the expected evolution of the common code in the course of time, on the objectives underlying its scientific development and on the resources invested in that development by the various partners. To achieve this, three types of activities are distinguished in the three main parts of the plan:

- Common activities on code design, generation of new CMC code and subsequent maintenance, and general support provided to local implementations and troubleshooting (chapter 1). The practices still differ between the ALADIN and the HIRLAM consortium.
- A limited number of core programs: commonly agreed programs of recognized strategic importance that will benefit all partners (chapter 2). At this stage, it has been proposed to define two core programs, starting in 2018: one on the scalability and efficiency of the dynamical core and one on providing a basic data assimilation setup for all members. At a later stage, other core programs may be introduced.
- Other R&D and/or operational activities which are carried out by a subgroup of members willing to invest resources in them, and/or which do not lead in the short term (within, say, 2 years) to the updating of the CMC's or a major extension of the sanity check system (chapter 3). The activities are described in the form of a set of work packages for each of the main areas of development: data assimilation, dynamics, physics parametrization, surface analysis and modeling, ensemble forecasting, very high resolution modeling, quality assurance and technical and computational development of the code system. In the detailed work package descriptions, which are given in chapter 4, it is attempted to specify the time scales on which the planned developments are expected to lead to new contributions to the common code. Certain work packages may directly lead to updates to the latest version of CMC codes, while others may represent more fundamental research, not providing short-term contributions to new code cycles.

A summary of the planned evolution of the code and of the associated staff commitments for all areas and work packages is provided in the annexes.

1. Common code design, generation and maintenance

1.1.1 General description of the ALADIN work

These are basically all the activities required to translate scientific developments in code suitable to enter the shared ALADIN-HIRLAM system during phasings, to validate and maintain this code, and to provide general support for implementing new code cycles operationally. These work packages contain the planned work related to the activities of the ALADIN program management, the Code Architect, the ALADIN CSSI, the ACNA and the ALADIN Support Team and the ALADIN Local Team Managers (LTMs), as there are described in the current ALADIN MoU. They are formulated in the following work packages (WP's):

- WP MNGT1:The management and ALADIN Support activities.
- WP COM1.1: The work of the ALADIN code architect to implement and monitor the definition of the CMC's, and to further develop the sanity check system where needed.
- WP COM2: The activities related to the creation of new cycles: the provision of contributions to new cycles and new CMC releases; participation in phasing activities and the related validation (sanity checks) of the CMC's, while taking care of the links with the global model configurations in the IFS/Arpege code framework.
- WP COM3: Support for maintenance and Partners' implementations of ALADIN-HIRLAM System in the ALADIN countries. These activities focus mostly on the ALADIN Coordination and Networking activities.

The table describing these work packages in more detail are found in Annex 3

1.1.2 General description of the HIRLAM work

These are basically all the activities required to translate scientific developments in code suitable to enter the shared ALADIN-HIRLAM system during phasings, to validate and maintain this code, and to provide general support for implementing new code cycles operationally. More specifically, they can be formulated in the following work packages (WP's):

- WP COM1.2: The work of the HIRLAM code analyst to implement and monitor the shared data assimilation code, and to further develop the sanity check system where needed.
- WP COM2: The activities related to the creation of new cycles: the provision of contributions to new cycles and new CMC releases; participation in phasing activities and the related validation (sanity checks) of the CMC's, while taking care of the links with the global model configurations in the IFS/Arpege code framework; and for Harmonie-Arome, making available new h-releases to the Toulouse repository, including documentation.

The tables describing these work packages in more detail are found in Annex 3.

1.1.3 General description of the LACE work

The planned LACE activities on development of ALADIN-HIRLAM system focus on various aspects of the model dynamics, physics, data assimilation and ensemble forecasting. The LACE working plan is integrated in the this ALADIN/HIRLAM/LACE RWP, and described in different WPs. Those contribution are mainly prepared by LACE area leaders on physics, dynamics, data assimilation and ensemble forecasting. The work of LACE data manager and system manager are also presented in the RWP.

1.2 The expected evolution of the common code

The R&D developments described in chapter 3 will eventually lead to an evolution of the CMC's in future code cycles. A detailed overview of the expected consequences of the research and development activities in chapter 3 on the next few cycles is presented in Annex 2. Below, the major aspects of code management are described (what makes the codes change, who, how, some hints on future perspectives or difficulties, organization and staffing).

The content and timing of a new code release depend on the nature of that release. The content of LAM code versions is being discussed between the LAM partners in various meetings and communication (HMG/CSSI meeting, e-mails in preparation of T-cycles, specific Harmonie system coordination etc.). So-called T-cycles in Toulouse are ALADIN-HIRLAM joint R&D code versions that are constructed in the same trunk as the IFS/ARPEGE code versions. Therefore, their timing especially is much guided by the decisions of the IFS/ARPEGE collaboration which settles the content and timing of the NWP codes jointly between Météo-France and ECMWF (Note: the ALADIN and HIRLAM consortia are observers in these meetings). In practice, a new IFS/ARPEGE joint cycle is being decided about every 9 months and these joint code versions are the base for subsequent T-cycles (eg. CY45 is the base for CY45T1). The table in annex 1 summarizes the timing of the forthcoming cycles, as agreed at the IFS/ARPEGE coordination meeting of 12 June 2017.

T-cycles receive R&D contributions from both ALADIN and HIRLAM and can be technically evaluated mostly by sanity checks (so-called "mitraillette" like for the forecast model configurations) and specific experimentation (eg. data assimilation). Building a T-cycle requires about two to three months of initial efforts for several staff members, and it is a known weakness that data assimilation is being validated usually much later than forecast model configurations.

Another type of code versions are those versions specifically prepared for promotion and installation with any ALADIN or HIRLAM member. In ALADIN, these code versions are called "export versions". They usually derive from T-cycles plus additional fixes or small improvements provided by the LAM partners. In HIRLAM, specific H-versions (H-cycles) are being defined, which include fixes but also a fair amount of R&D developments. Thus the HIRLAM use to define several sub-versions starting from a T-cycle (close) base version. The practical details of how "export versions" or "H-cycles" are being prepared differ between the two consortia, because the final objective of evaluation is not the same. In ALADIN, the "export version" is considered as a technically sane base version which however will require specific local work for operational implementation (like to run long series of meteorological evaluation on any national domain). HIRLAM wish to further evaluate at consortium-level a number of national domains and applications leading eventually to the definition of a Reference Forecast System. For the coming years, and in view of the single consortium, more shared technical maintenance and extension to components of the data assimilation will be sought. On the contrary, it is not foreseen to push the common maintenance activity down to the level of common (pre-)operational evaluation. The latter evaluation is indeed left to the activity of member NMS teams or sub-groups willing to start a common activity there.

One aim of the thematic work package sheets in chapter 3 is to provide an overview of the R&D developments and expected code implementations at a time scale of about 2-3 years. A draft list of R&D contributions, as derived from the list of tasks and T-code developments, is presented in Annex 2.

For the sake of brevity, only a few milestone developments are summarized in this chapter 1. For the forecast model CMC's, several R&D tasks in the dynamics will provide new possibilities for the code of the dynamical kernel: improved Vertical Finite Elements for the nonhydrostatic (NH) code, Quasi-Elastic code as an alternative semi-implicit NH code. The two-moment microphysics scheme LIMA is expected to become available for research in the shared system for AROME. The ALARO physics will be improved like for the microphysics/turbulence and surface/turbulence interactions, and calling SURFEX will become possible from ALARO. The Harmonie-Arome configuration will have improvements in the surface code and improved options particularly in the microphysics and radiation schemes.

The perhaps most prominent evolution of the atmospheric data assimilation code would be the almost finished re-factoring of the FORTRAN codes for use in OOPS. This completion, while being purely technical (programming aspects), is presently expected by about CY47. Once done, a thorough testing of variational assimilation using OOPS for 3D/4D-VAR and for LAM forecasts can be envisaged, as well as defining technically very stable versions of EnVar and hybrid VAR/EnVar solutions. Reaching this level will open the floor for pre-operational tests of OOPS binaries as well as it will enable a fostering of the scientific innovations in algorithms. The use of new satellite observations will be continued (like IASI-NG, MTG-IRS, Aelous, scatterometer on board of various platforms etc.) and progress on assimilating all-sky radiances is expected. Assimilation of GNSS data will be technically extended (slant delays, improved variational bias correction, etc.), as well as aircraft data (Mode-S, AMVs). The evaluation of OPERA European radar data will be extended, and research on exploiting dual-polarization radar reflectivity observations will go on. For surface assimilation, the CANARI configurations are likely not to evolve too much but the CANARI software will require steady maintenance over the next years (this is an area where the ALADIN-HIRLAM know-how is sparse). New surface assimilation solutions based on Extended or ensemble Kalman Filter codes will be investigated, though it hardly is possible to state whether such codes would be made available in the common codes quite soon, or perhaps more likely first within the groups of scientists who will actually work in this area. Progress on using satellite-derived information for soil properties is expected as well.

Integration of the scientific novelties requires adapting the associated codes to the most recent official common version, as well as solving code conflicts where the same piece of the system is being touched by two or more developments. Another significant source of code changes is the evolution of the IFS/ARPEGE system itself, which requires adaptation of the LAM codes (at interfaces, on data structure, on architecture of the codes). The adaptation of the LAM codes to the evolution of the IFS/ARPEGE system is mostly handled during the code phasing efforts that are regularly being organized at Météo-France (at least once per year). During this phasing work, the last code release of the IFS (so-called R-cycle) is merged (or synchronized) with the last version of the T-cycles. The result is a new IFS/ARPEGE code release which will become available in both ECMWF and Météo-France's source code repositories. Similarly, when constructing a T-cycle, the core phasing work is organized at Météo-France, with specific preparation work discussed with and organized by the LAM partners (so-called "pre-phasing" of codes, cross-check of scientific and technical issues). A T-cycle can also be a good opportunity for implementing specific code optimization features.

Staff from the consortia (mostly ALADIN until now) are invited to Météo-France and provide about 1 FTE of additional manpower for this sometimes tedious code phasing. Météo-France devote between 5 and 7 FTE to this effort per year and this figure is likely to increase to about 8-9 FTE in the next two years because of the OOPS efforts. For the future, the possibility to increase the efforts of preparatory technical work, feasible in a decentralized manner (at partner NMS), will be assessed, as well as means to increase decentralized common code maintenance. Potential tools could be mirror source code repositories where specific development or phasing branches of the common codes could be prepared. The share of a *logical* common trunk of the source codes would probably be a prerequisite here, where *logical* rather refers to sharing a common labeling of master and remote trunks, rather than to a physically co-located repository. Another area for improvement is the progressive closer interaction between ALADIN and HIRLAM lead scientists but also System Experts. Today's teleconferences like the ACNA Webex meetings or specific Working Week remote discussions could be considered as the embryo of regular teleconferences about System evolution.

The specific tasks for cycling and code maintenance, along with staffing and manpower for both the technical core activity and the required coordination, are listed in the WP sheet COM2.

One complicating factor in the assessment of when new developments can be expected to enter the common code, exists for the SURFEX modules. This code is developed by the SURFEX community and maintained in specific repository, which is separate from the repository of the common NWP code. New SURFEX versions are not *specifically* synchronized with the release of new T or H-cycles. For SURFEX major specific model developments which have been created by partners from the ALADIN or HIRLAM communities, it has been agreed in the past that these are phased into the SURFEX repository first, and then officially enter the NWP repository when a new version of SURFEX is introduced there. However, this has on occasion led to long delays before certain developments relevant for the NWP community became available in the common NWP repository. Alternatively, some SURFEX changes have been introduced first in the NWP repository, in which case however they needed to be, in addition, committed separately into the SURFEX trunk (double-commit). Ways to improve this situation are being considered.

2. Core programmes

2.1 Dynamics and scalability

The present non-hydrostatic dynamical core consists of a spectral formulation, with a semi-implicit time stepping and semi-Lagrangian advection. It combines high accuracy with computational efficiency on present machines, largely due to the feasibility of using long time steps. However, for many of the components of the dynamical core it can be questioned whether the meteorological accuracy and stability, and the computational efficiency, will still be sufficient for use at higher resolutions (over steep orography) and on future, more massively parallel computer architectures. *How should the dynamical core evolve so that also in the future the combination of high accuracy and computational efficiency can be guaranteed?* The work plan presented here represents a joint strategic perspective of the two consortia to address this question.

To answer this question, investigations will be made of various promising alternative dynamics schemes. Also, LAM code developments will be carried out in the context of ECMWF's Scalability programme, ensuring that LAM needs are taken into account in the new Atlas data structure framework. In view of possible long-term fundamental changes in the dynamics, this program will maintain a well-defined coupling between the physics and the dynamics. Given the long-term perspective of this program we do not expect any immediate impact on local implementations of the ALADIN-HIRLAM shared codes; the value of this program lies in the scientific outcomes, addressing fundamental questions related to the desirable evolution of the dynamical core and providing an enrichment of our numerical tools to make us ready for the future.

The core programme Dynamics and Scalability consists of the following work packages (WPs):

- The development and assessment of an alternative quasi-elastic, formulation of the model equations, believed to be more stable for steep orography conditions at high model resolution (WP CPDY1).
- Assessment of gridpoint alternatives (more stable and less demanding in global communications) to the spectral solver (WP CPDY2)
- Assessment of HEVI schemes as alternative (less demanding in communications) to semi-implicit time stepping (WP CPDY3)

- Physics-dynamics interface (WP CPDY4)
- Development of LAM components in the Atlas data structure framework (WP CPDY5)

The tables describing these work packages in more detail are given in chapter 4.

2.2 Basic data assimilation setup

Although most members of ALADIN and HIRLAM are active with data assimilation at some level, there are still ~10 members who do not run with data assimilation operationally. To help those members that do wish to use data assimilation operationally, to achieve at least a basic data assimilation setup, including the handling of a (limited) set of observations, in their operational suites, some structural coordination across the different consortia (ALADIN, HIRLAM, LACE) is needed.

The aim of this program is

1. to develop a cross-consortia coordination to help all ALADIN and HIRLAM NMS's that wish to apply data assimilation operationally, to set up a basic 3D-Var data assimilation cycle with a (limited) set of observation data.
2. While doing so, define the required codes and build a list of ALADIN-HIRLAM common codes for the basic data assimilation configuration. This can include codes for assimilation algorithms and for observation processing, and scripts to run the assimilation cycles.

The programme is still under construction. The precise content of the work plan will be progressively built in concert between the data assimilation leaders of ALADIN, HIRLAM and LACE. At this stage, no detailed work packages can be presented, but the following roadmap is envisaged:

1. Arrange local data acquisition of a set of conventional observations (activities started in 2017)
2. Test the correct pre-processing and ingest of acquired data in the programme BATOR (started in 2017)
3. Set up a basic observation monitoring system (planning and activities in 2018)
4. Set up a basic cycling system (planning and activities in 2018)
5. Define and document the common code for the basic data assimilation configuration, as a starting point for extending the CMC concept to the data assimilation system (2018)
6. implement and assess the basic data assimilation configuration locally (2019 and later)

Within the ALADIN consortium some activities have already been kicked off (as announced during the 2016 ALADIN General Assembly). The table describing this work package in more detail are given in chapter 4. Currently a coordination for this program is lacking to pursue these activities in 2018.

3. Other R&D activities

3.1 General description of work packages per area

3.1.1 Atmospheric data assimilation

Presently, data assimilation in the operational suites of ALADIN and HIRLAM members is still based on 3D-Var. While the 3D-Var system can still be improved in various ways (WP DA1), the focus in Meteo-France and the HIRLAM community is increasingly shifting towards the introduction of more advanced flow-dependent assimilation methods (WP DA2). In HIRLAM the development of a 4D-Var system is far advanced, and for ensemble forecasting purposes also a 3D-VAR/LETKF system has been developed. On the longer term, a more integrated system for ensemble forecasting (3- or 4D-EnVar) is envisaged, as this appears to offer a higher quality at significantly lower computational cost and better scalability. Meteo-France and HIRLAM are pursuing somewhat different approaches for this.

A second trend is that the model is increasingly being used for nowcasting applications. It is being considered how data assimilation configurations may need to be adapted in order to optimally function in the nowcasting range (WP DA5). Aspects to be considered here are the use and limitations of rapid cycling strategies and high-frequency observations, choice of initialization methods and time windows, and the options for giving cloud and radar observations greater weight through e.g. the application of cloud initialization and field alignment techniques.

In the use of observations, the main aims are (a) to make better use of observations which have already been incorporated into the data assimilation system (WP DA3), e.g. through variational bias corrections; and (b) to introduce new observation types of interest (WP DA4).

The LAM activities in the context of the OOPS redesign of the data assimilation code are described in WP DA6. Finally, WP DA7 contains the work taking place on observation pre-processing (e.g. contributions to the ECMWF COPE project) and the developments on observations diagnostics and monitoring tools.

3.1.2 Dynamics

The present dynamical core of all three CMC's is spectral, with semi-Lagrangian advection and semi-implicit time stepping. The core programme on dynamics and scalability describes the research on the longer-term evolution of this dynamical core (and the possible need to replace large components of it), which may be required to ensure continued good performance (meteorologically and computationally) in the future. The dynamics activities outside the core programme deal with shorter-term studies and adaptations of components of the existing core: the lateral boundary treatment (WP DY4), the time stepping (WP DY2), the discretization (WP DY3) and the semi-Lagrangian advection (WP DY4).

3.1.3 Atmospheric physics parametrizations

The key difference between the three present canonical model configurations Arome-France, Harmonie-Arome and Alaro, lies in the choices for the physics parametrizations. Hence, the work packages in this area have been organized along the line of CMC's: WP PH1 describing the research on Arome-France physics, WP PH2 on Harmonie-Arome, and WP3 on Alaro. WP PH4 concerns the development, maintenance and use (for validation purposes) of the common 1D MUSC environment for the two Arome-based model configurations.

3.1.4 Surface analysis and modelling

In this area, the following types of activities can be distinguished:

- the development of more advanced surface assimilation algorithms, to replace the present OI/CANARI system and permite the assimilation of remote sensing surface data (WP SU1)
- the use and assessment of (new) surface observations (WP SU2)
- the validation of existing SURFEX model options for NWP (WP SU3)
- the further development of (new) SURFEX model components (WP SU4)
- assessment and improvement of the surface characterization (WP SU5)
- coupling with the sea surface/ocean (WP SU6)

3.1.5 Probabilistic forecasting

The work packages in this area have been organized along the lines of the existing ensemble systems:

- the development of convection-permitting ensemble systems: the Arome-France EPS system PEARO (WP E1), the HarmonEPS system (WP E2.1-5), and the LACE convection-permitting ensemble systems (WP E3).
- the development, maintenance and operation of the two European-scale EPS systems LAEF (WP E4) and GLAMEPS (WP E5)
- the development (by HIRLAM) of ensemble calibration and post-processing techniques (WP E6)

3.1.6 Quality assessment and monitoring

The work in this area entails the following activities:

- The development of the HARP verification system (WP QA1)
- The development of new verification methods (WP QA2)
- Quality assessment of Harmonie-Arome cycles and alleviation of model weaknesses (WP QA3)
- Verification and quality control at Meteo-France (WP QA4)

3.1.7 Technical code and system development

The work in this area contains the following types of activities:

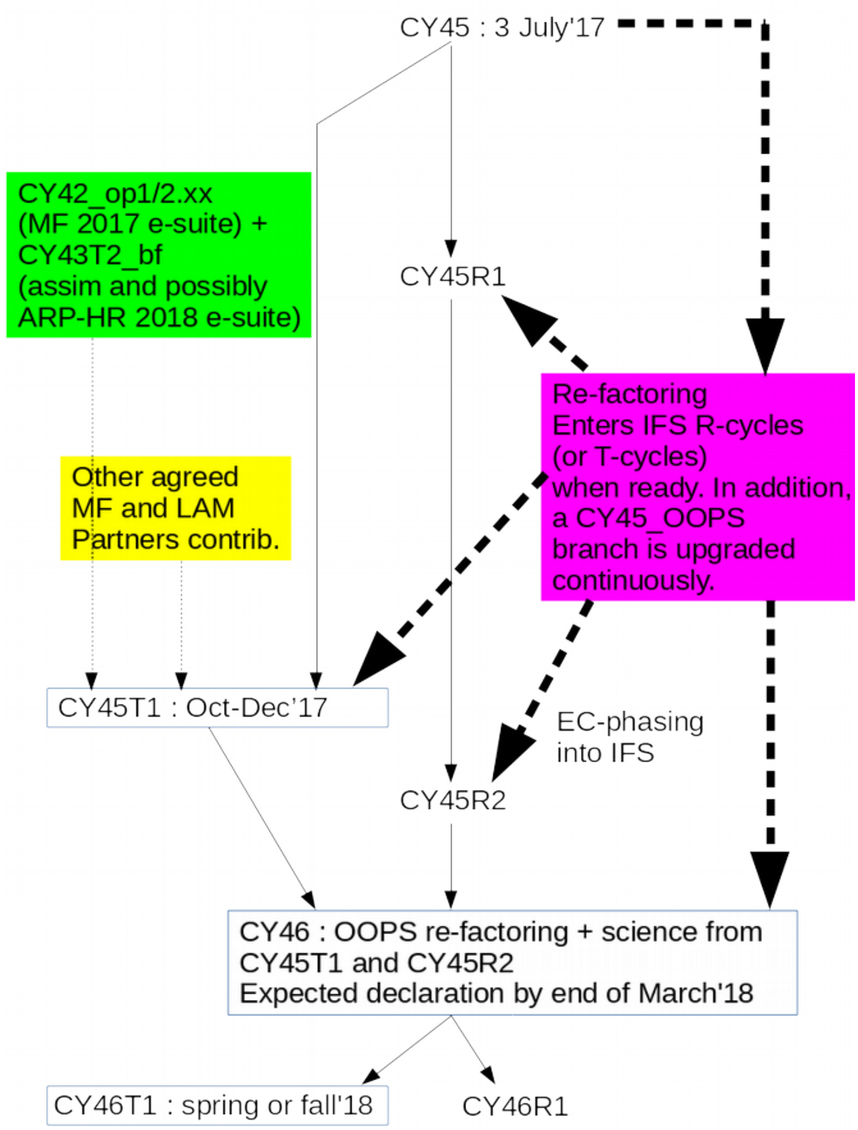
- code optimization and code cleaning (WP SY1)
- the maintenance and development of the Harmonie Reference System (restricted to those activities not aimed at the development, validation and introduction of canonical model configuration code (which is described in WP COM2)) (WP SY2)
- the revision of the Harmonie scripting system (WP SY3)
- maintenance and support of the HIRLAM model (WP SY4)

3.1.8 Towards high-resolution modelling

The aims in this area are to prepare for increased operational resolution of our model and ensemble suites, and to study in which ways the models (and ensembles) should be adapted to permit them to be run at resolutions of ~200-1000m. These activities (WP HR1) are truly transversal in the sense that they require expertise across the full width of NWP model development.

Annex 1: Time line of future cycles

Joint cycle	ECMWF	MF	Start of phasing	Declaration	Misc. / Oper plans
CY45			March 2017	June 26th	MODEL object re-factoring
		CY45T1	2nd October 2017	End of November 2017	Including Aladin and Hirlam
	CY45R1		May 31st 2017	August 2017	Science tbc Operational Jan/Fab `18
	CY45R2		July 2017	October 2017	12h overlapping DA (op. Jul `18)
CY46			Start Jan 15th, 2018	End of March 2018	
		CY46T1	May-June or Sept-Oct 2018		Timing depending on schedule of CY47
	CY46R1				OOPS?
CY47			Autumn 2018 or winter/spring 2019		Early or late scenario. To be further discussed.
	CY47R1				New HPC technical (Q2 2020)



Annex 2: Common cycles and preliminary content

CY45: March-April 2017.
Content:

- OOPS re-factoring:
  - adapted trajectory codes for simplified physics (D. Salmond)
  - first bits and pieces for VarBC (R. Stappers, A. Geer)
  - fixes and updates to enable multi-incremental IFS 4D-VAR from OOPS-IFS (M. Hamrud, D. Salmond)
  - adapted codes to redirect code printouts from std.out to listing (NULOUT) (M. Hamrud)
  - an updated version of Full-POS changes towards OOPS and conf 903 (R. El Khatib, E. Arbogast)
  - [Major change in the model codes:] <u>pass by arguments MODEL variables</u> and parameters (aka SPAMing). Partially remove global variables and pass all fields and parameters as arguments via Fortran structures. SPAMing is implemented via a Python script followed by some necessary manual intervention (O. Marsden for the IFS/Arpège codes, in coordination with A. Mary)
  - The SPAM re-factoring also applies to relevant LAM codes and variables (A. Mary, W. Khalfaoui)
- a few technical adaptations of the codes, outside the scope of OOPS re-factoring: simplifications in the SL code (K. Yessad)

CY45 was declared on 28 June 2017.

CY45T1: Oct-Dec 2017. Deadline for contributions Thursday 28 September, 23:59 CET.
Provisional input:

- System operational aspects (Météo-France o/e-suites):
  - Fixes phased on top of CY45, for enabling to run screening and minimization in Arpège 4D-VAR and Arome 3D-VAR ***in CY43T2*** (P. Moll, F. Suzat, C. Payan, P. Brousseau, E. Arbogast)
  - *Fixes for CANARI in CY43T2, tbc* ()
  - Phased contributions to MF's Arpège+Surfex e-suite based on CY42_op2 (GMAP staff)
- System technical aspects:
  - PREP with FA file formats, deactivate default use of LFI format (Ph. Marguinaud)
  - FA file format support in FESTAT (R. El Khatib)
  - fixes for LAM+SURFEX and MPI in order to enable MPI tasks running in E-zone regions only (REK)
  - optimizations for Full-POS; important updates for Full-POS in OOPS (configuration 903 for Arpège and Arome, and PostProcessor object in OOPS) (REK)
  - pruning of FEMARS in CNT3/IFS code (REK)
  - drHack: a runtime profiling facility to dynamically generate call tree information for any configuration (F. Suzat)
- Diagnostics and specific post-processing:
  - add surface fields to DDH diagnostics (Y. Seity)
  - Flexible DDH OpenMP debugging (F. Voitus):
    - Introduction of a new DDH type devoted to the DDH budget in APL_AROME
    - Fix for storing and cleaning the DDH structure when KSTEP=0

- Arpège and Arome model dynamics:
    - first codes for implementing the Quasi-Elastic NH equations in global and LAM (for finite differences at least) (K. Yessad, F. Voitus)
    - vertically variable SITRA in SI operator (K. Yessad)
    - more flexible filtering of orography for PGD files (KY)
    - simplifications in the code of LASCAW when interpolating half-level fields (KY)
    - if ready: enable to only switch on higher-order interpolations in the last iteration of P/C scheme (could be numerically cost-effective when LPC_FULL, KY)
- Arome physics:
    - add a term of deposition for the microphysics (Y. Seity)
    - a significant rewrite of the ICE3 microphysics code in order to reduce the dependency upon the time step value (Note: some bugs fixed while rewriting) (S. Riette)
    - recent updates for computing gust winds, from the CY42 e-suite (enable to compute gust winds over a different time range than the forecast range of the output file) (Y. Seity)
    - *implement SURFEX V8.1 ? Tbc (Y. Seity)*
    - first version of the LIMA two-moment microphysics scheme (Y. Seity, B. Vié)
- Assimilation methods:
    - updates for Ensemble Data Assimilation (EDA) and for using grid point σb's in AROME. This contribution includes a significant rewrite of LSPFCE=.FALSE. for LAM (Y. Michel)
    - enable to diagnose the content of one column of B; enable NETCDF I/O of LAM stabal and stabcv files for the B-Matrix (Y. Michel)
    - optimization of code for filtering B matrix structures and for computing the inflation factor for AROME EDA (previous codes already in CY43T1) (Y. Michel)
- Observations:
    - enable monitoring of data from the MTVZAGY microwave radiometer on board METEOR (Russia) (Ph. Chambon, F. Suzat)
    - enable monitoring, possibly assimilation, of data from the AMSR2 microwave radiometer on board GCOM-W1 (Japan) (P. Chambon, F. Suzat)
    - implement monthly varying versions of microwave surface emission atlases (F. Suzat)
    - monitoring and potential use of scatterometer winds from the Indian satellite ScatSat-1 (tbc, C. Payan in coordination with ECMWF/G. De Chiara)
- ALADIN:
    - fix for quadratic/cubic coupling (Jan, following Jozef and Alexandre)
    - fixes for ALARO-1 (Jan Masek)
    - combination of SURFEX with TOUCANS (D. Degrauwe and R. Hamdi)
    - *prognostic graupel scheme "LGRAPRO" (B. Bochenek) tbc*
    - phasing of VFE work for NH dynamics (Petra Smolikova)
    - note: a fix for writing out spectral orography in e923 clim files was added as well, already in CY45_main (originally fix by F. Taillefer)
- HIRLAM: final list is under discussion
    - observation pre-treatment aspects, Bator/Oulan (mostly E. Whelan)
    - microphysics and radiation ()
    - Surfex changes
    - assimilation code (M. Lindskog, others) – Jb, Jk, … -
    - miscellaneous cleaning and fixing (U. Andrae)
- OOPS re-factoring:
    - further reorganization, encapsulation and passing-by-arguments of the LBC code for LAMs (H. Dhouioui, A. Mary, K. Yessad, B. Bochenek)

- remove the Tomas' trick for YOMPHY* variables. Proper handling of the MODEL parameters inside calls to MF obs operators (A. Mary)
- more generally, finalize the adaptation of Arpège options to the re-factored observation operator codes of phase 2: APACHE, ACHMTTL/AD (MF/ OBS team)

Expected timing for declaring CY45T1 in MF's GIT repository is in December 2017.

Note: some of the OOPS re-factoring items will be managed as a specific OOPS branch on top of CY45 first (but might enter in parallel in CY45R1, R2 or T1 depending on EC or MF possibilities).

CY46: January-March 2018. The start of build will be around 15 January. This cycle will contain several new stages of the FORTRAN re-factoring of the IFS for OOPS.

Provisional content:

- OOPS re-factoring:
  - final part of VarBC for OOPS-IFS
  - LTOVSCV
  - code adaptation for multi-incremental (multiple resolution) IFS 4D-VARremoving/pruning many of the global model variables references in USE statements (duplicated with passing by arguments of CY45)
  - any other content of the CY45_OOPS branch that might not already have done it into an interim cycle in either Reading or Toulouse
- scientific contents of CY45T1 and CY45R2/R1

Expected time of final declaration of CY46 is end of February 2018.

CY46T1: spring or autumn 2018.

Provisional content:

- Diagnostics and specific post-processing:
  - harmonize the names of fluxes and tendencies (3D and 2D) in ARPEGE and AROME (flexible DDH, F. Voitus)
  - finish the implementation of DDH terms from the dynamics (flexible DDH, F. Voitus)
- Arpège physics:
  - tunings and code adaptations needed for Arpège new resolution T1800C2.2
  - *first rewrites of PCMT code (J.-M. Piriou, Y. Bouteloup)*
  - *review stability functions for PBL with respect to consistency of energy cycle, potential impact of Lewis number # 1 (P. Marquet)*
  - *TL linear physics for 4D-VAR: updates in microphysics (C. Loo)*
  - *other Arpège physics changes ??*
- Arome physics:
  - *improved ICE3/ICE4 for forecasting hail (Y. Seity, S. Riette)*
  - *first version of LIMA available (if not already in CY45T1) (Y. Seity, S. Riette)*
  - *diagnose visibility for post-processing and end-user applications (O. Jaron, Y. Bouteloup, I. Etchevers)*
  - *other Arome physics changes ??*
- Assimilation methods:
  - improvements on EDA for AROME, use of EDA information in AROME-France 3D-VAR (Y. Michel, P. Brousseau, L. Berre, B. Ménétrier)

- Observations:
  - AMDAR humidity data: optimize QC and assimilation in ALARO or AROME 3D-VAR (P. Moll, A. Trojakova, F. Meier)
  - first codes for assimilating all-sky radiances using a Bayesian inversion method (P. Chambon)
  - new satellites/instruments: 1) Aeolus L2 HLOS winds, 2) MTG-IRS, 3) IASI-NG, 4) winds from various scatterometers (GMAP/OBS)
  - adapt codes for assimilating European radar data from OPERA (E. Wattrelot)
  - preparations for assimilating radar dual-polarisation data (E. Wattrelot)
  - use of infrared emissivity atlases for the use of IASI skin temperature retrievals (V. Guidard)
  - *first potential code adaptation of IFS/Arpège/LAM codes in order to test COPE3 pre-processing tools (E. Wattrelot, M. Dahlbom) tbc*
- ALADIN: see list below
- HIRLAM: see list below
- OOPS re-factoring:
  - Full-POS2 adaptation for OOPS, possibly not yet fully completed (later for CY47 or CY47T1) (R. El Khatib)
  - adaptation of LAM MODEL components, possibly DDH code, to OOPS (A. Mary)

CY47: autumn 2018 or winter/spring 2018-2019

Provisional content: tbd with ECMWF in the forthcoming IFS/Arpège coordination meetings

CY47T1: spring 2019 or autumn 2019

Provisional content:

- Arpège and Arome model dynamics:
  - 3D grid point solver for SI hydrostatic model (research version) (L. Auger ?)
- Arome physics:
  - horizontal gradients and horizontal turbulent mixing treated within the Arpège/Arome code algorithm, probably building on available spectral/grid point arrays and SL stencil computations (R. Honnert) – for tests in sub-km Arome configurations
- Assimilation methods:
  - first "official" codes for EnVar in ARPEGE or AROME implemented in common libraries, including interface codes to OOPS/C++ (E. Arbogast, Y. Michel, T. Montmerle)
- Observations:
  - *GNSS ZTD horizontal gradients observation operator (P.Moll) tbc*
- ALADIN: see list below
- HIRLAM: see list below
- OOPS re-factoring and prototypes:
  - in the FORTRAN code libraries: any potentially missing issue after CY47, or bug-fixes for running the OOPS binaries for standard configurations (4D-VAR Arpège, 3D-VAR Arome, Unit tests with Arpège or Arome data, Arpège and Arome forecast models etc.)
  - first implementations in official SCR of OOPS/C++ towards FORTRAN/IFS interface codes, enabling the 4D-VAR and 3D-VAR prototypes to run
  - FORTRAN and interface codes for EnVar solutions as developed for ARPEGE and AROME

ALADIN-HIRLAM listed potential contributions for either CY46T1 or CY47T1, as derived from the joint Rolling Workplan for 2018:

- ALADIN:
  - *Dynamic definition of the iterative time schemes: call the corrector step "on demand" (J. Vivoda, tbc)*
  - physics-dynamics interface consistent with energy budget, thermodynamics including mixed phases and NH equations (D. Degrauwe)
  - *prognostic graupel scheme "LGRAPRO" if not already in CY45T1 (B. Bochenek) tbc*
  - *other Alaro physics changes ??*
  - *Development and implementation of new random number generator (SPG) suitable for LAM EPS environment (M. Szucs) ??*
- HIRLAM:
  - LAM DA methods: back and forth nudging (O. Vignes), variational NH balance (C. Geijo)
  - assimilation of all-sky radiances using the ECMWF method (R. Randriamampianina)
  - GNSS slant delays (S. de Haan)
  - 1D model studies, potential code changes in order to improve the representation of fractional cloud cover for Harmonie-Arome (W. de Rooy)
  - *other Harmonie-Arome physics changes ??*
  - codes linked with flow-dependent aspects for Harmonie DA (4D-VAR, hybrid, etc.)
  - adapted changes for the assimilation of existing observations, if necessary and after coordination with MF and other partners: radar (OPERA), Mode-S, GNSS ZTD, scatterometer winds, AMVs, clear-sky radiances, cloud-affected radiances, near-ground observations, radiosonde data
  - Assimilate wind data from recreational hot-air balloon flights (C. de Bruijn)
  - replace upper boundary spectral nudging by a relaxation of either Davies or weak constraint type (M. Kupiainen)
  - fix problems with the pattern generator of SPPT (O. Vignes, A. Callado)
  - *introduce EPPES in common codes? EPPES is an ensemble prediction and parameter estimation system developed in Finland, which will be used to find optimal values for sensitive parameters, and their PDF's. This will in turn be used for perturbing the parameters using a spatio-temporal correlation pattern (SPP-approach) (U. Andrae)*
  - continued work and potential code changes for computing random perturbations based on the LAM B-matrix structure (J. Bojarova, O. Vignes, U. Andrae)
  - surface perturbations (test different scales for different parameters), test alternative SST perturbations (O. Vignes, U. Andrae)
  - add code for perturbing roughness length for heat and moisture, over various vegetation types, assess optimal lengthscale of these perturbations (O. Vignes, U. Andrae)

Annex 3: Work packages and staff resources for 2018:

Work package	Description	Resources (pm) ALADIN[1]	Resources (pm) HIRLAM[2]	See page
MGMT1	Management and ALADIN support activities	45		*18*
MGMT2	Management LACE	22		*19*
COM1.1	ALADIN Code architect activities	1[3]		*20*
COM1.2	HIRLAM Code analyst activities		6	*21*
COM2	Code generation and maintenance	108.5	12.5	*22*
COM3.1	Support for maintenance and Partners' implementations of ALADIN system	6.5		*23*
CPDY1	Quasi-Elastic (QE) system	6		*24*
CPDY2	Development of methods for solving the implicit equation in gridpoint space.	34		*25*
CPDY3	Horizontally Explicit Vertically Implicit (HEVI) methods with ALADIN-NH core	8.5		*26*
CPDY4	Physics-dynamics interface	5		*27*
CPDY5	Development of LAM components in Atlas	3		*28*
CPDA1	Core programme Basic data assimilation setup	28		*29*
DA1	Further development of 3D-Var (alg. Settings)	21.5	9	*31*
DA2	Development of flow-dependent algorithms	41	17.25	*33*
DA3	Use of existing observations	106	24.5	*35*
DA4	Use of new observations types	78	7	*37*
DA5	Development of assimilation setups suited for nowcasting	21.5	4.5	*39*
DA6	Participation in OOPS	24.5	2	*40*
DA7	Observation pre-processing and diagnostic tools	13.5	9	*42*
DY1	Boundary conditions and nesting	2	2	*43*
DY2	Time-stepping algorithm	5	2	*44*
DY3	Vertical discretization	3	0	*45*
DY4	Semi-Lagrangian advection	3	0	*46*
PH1	Developments of AROME-France (and ARPEGE) physics	86	0	*47*
PH2	Developments of HARMONIE-AROME physics	3	31.5	*48*
PH3	Developments of ALARO physics	45	0	*50*
PH4	Common 1D MUSC framework for parametrization validation	5	1	*51*
SU1	Assimilation algorithms for surface assimilation	17.5	15	*52*
SU2	Use of observations in surface assimilation	6.5	5	*54*

1 In ALADIN : 1 Full Time Equivalent : 1 FTE/year = 11 person.month per year
2 In HIRLAM : 1 Full Time Equivalent : 1 FTE/year = 12 person.month per year
3 ALADIN code architect coordination activities is a half time position, but the Code architect other 4.5 p.m. CA activities are spread across the other WPs (Altas, SURFEX and MUSC).

SU3	SURFEX: validation of existing options for NWP	22	1	*55*
SU4	SURFEX: development of model components	10	7.75	*57*
SU5	Assess/improve quality of surface characterization	1	7.5	*58*
SU6	Coupling with sea surface/ocean	9	3	*59*
E1	Arome-France EPS (PEARO)	51.5	0	*60*
E2.1	Development of convection-permitting ensembles: HarmonEPS - Physics perturbations	0.5	15	61
E2.2	Development of convection-permitting ensembles: HarmonEPS - Initial conditions perturbations	3	10	62
E2.3	Development of convection-permitting ensembles: HarmonEPS - Surface perturbations	1.5	14.5	63
E2.4	Development of convection-permitting ensembles: HarmonEPS - Lateral boundary perturbations	0	2	64
E2.5	Development of convection-permitting ensembles: HarmonEPS - HarmonEPS system	1	4.75	65
E3	Development of convection-permitting ensembles: LACE	17	0	66
E4	Development, maintenance and operation of LAEF	19	0	67
E5	Production and maintenance of GLAMEPS	0	1	68
E6	Ensemble calibration	0	7	69
QA1	Development of HARP	5	2.5	70
QA2	Development of new verification methods	3	9.5	71
QA3	Quality assessment of new HARMONIE-AROME cycles and alleviation of model weaknesses	0	15	73
SY1	Code optimization	11	5	74
SY2	Maintenance and development of the Harmonie Reference System	0	19.75	75
SY3	Revision of the Harmonie scripting system	0	5.5	77
SY4	Hirlam maintenance and support	0	0.5	78
HR1	(Sub)-km configurations and turbulence R&D activity	38.75	20	79

ALADIN/HIRLAM/LACE WorkPackage description : MGMT1

WP number	**Name of WP**
MGMT1	Management and ALADIN support activities
WP main editor	**Piet Termonia and Patricia Pottier**

Table of participants

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth or External project**
PiTe	Piet Termonia	RMI Belgium	11
ClFi, AlJo, FrBo, ErEs, PaPo	Claude Fischer, Alain Joly, François Bouyssel, Eric Escalière, Patricia Pottier	Météo-France	19
LTM-Dz	LTM	ONM Algeria	1
LTM-Au	LTM	ZAMG Austria	1
LTM-Be	LTM	RMI Belgium	1
LTM-Bg	LTM	NIMH Bulgaria	1
LTM-Hr	LTM	DHMZ Croatia	1
LTM-Cz	LTM	CHMI Czech	1
LTM-Hu	LTM	OMSZ Hungary	1
LTM-Mo	LTM	Maroc Meteo	1
LTM-Pl	LTM	IMGW Poland	1
LTM-Pt	LTM	IPMA Portugal	1
LTM-Ro	LTM	Meteo Romania	1
LTM-Sk	LTM	SHMU Slovakia	1
LTM-Si	LTM	ARSO Slovenia	1
LTM-Tu	LTM	INM Tunisia	1
LTM-Tk	LTM	MGM Turkey	1

WP objectives

This WP lists the main activities of the Management of the Consortium as defined in the ALADIN MoU5, including the support activities to the Program Manager.

Descriptions of tasks

Task	**Description**	**Participant abbrev.**	**Type of deliverable**
MGMT1.1	Execution of GA decisions	PiTe	
MGMT1.2	Organisation, coordination, minutes of the GA, PAC, HMG-CSSI, meetings, ALADIN Wk, WW and joint meetings with HIRLAM	PiTe, PaPo, ClFi	
MGMT1.3	Elaboration and execution of the RWP, reporting to the GA	PiTe	RWP submitted to GA
MGMT1.4	Preparation and execution of the annual budget	PiTe, PaPo	budget submitted to GA
MGMT1.5	Management and monitoring of the contributions of Members (incl. manpower), reporting to the GA	PiTe, PaPo	manpower submitted to GA
MGMT1.6	Preparation and publication of a joint ALADIN-HIRLAM Newsletter	PiTe, PaPo	2 publications/year
MGMT1.7	Maintenance of an ALADIN official web-site where all the relevant information about the project is published	PaPo	http://www.umr-cnrm.fr/aladin/
MGMT1.8	Communication and coordination of operational changes of the commun system (ARPEGE-ALADIN-AROME) in MF	AlJo, FrBo, ClFi	
MGMT1.9	Coordination of the ALADIN activities of their respective national ALADIN project teams	all LTMs	
MGMT1.10	Computing support to ALADIN users of MF machines, access to MF machines, offices	ErEs	

t-code deliverables

Task	**Responsible**	**Cycle**	**Time**

Non-t-code deliverables

Task	**Responsible**	**Type of deliverable**	**Time**

ALADIN/HIRLAM/LACE WorkPackage description : MGMT2

WP number	**Name of WP**
MGMT2	Management LACE
WP main editor	**Yong Wang and Andrea Ehrlich**

Table of participants

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth or External project**
YoWa	Yong Wang	ZAMG Austria	6
AnEh	Andrea Ehrlich	ZAMG Austria	6
MaBe	Martin Bellus	SHMU Slovakia	2
OlSp	Oldrich Spaniel	SHMU Slovakia	1
NePr	Neva Pristov	ARSO Slovenia	2
PeSm	Petra Smolikova	CHMI Czech	2
MaMi	Mata Mile	OMSZ Hungary	2
AlTr	Alena Trojakova	CHMI Czech	1

WP objectives

This WP gives a list of LACE management activities on development of ALADIN-HIRLAM system

Descriptions of tasks

Task	**Description**	**Participant abbrev.**	**Type of deliverable**
MGMT 2.1	Execution of LACE council decisions	YoWa	
MGMT 2.2	Actitivties on LACE related meetings, such LSC, council meeting and managem	All	
MGMT 2.3	Organisation, Monitoring and execution of LACE work plan	All	
MGMT 2.4	Reporting to LACE council	YoWa	
MGMT 2.5	Preparation and execution of the annual budget	YoWa, AnEh	
MGMT 2.6	Maintenance of LACE official web-site	ÓlSp	

t-code deliverables

Task	**Responsible**	**Cycle**	**Time**

Non-t-code deliverables

Task	**Responsible**	**Type of deliverable**	**Time**

ALADIN/HIRLAM/LACE WorkPackage description : COM1.1

WP number	**Name of WP**
COM1.1	ALADIN Code architect coordination activities
WP main editor	**Piet Termonia and Daan Degrauwe**

Table of participants

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth or External project**
DaDe	Daan Degrauwe (coordination work only, technical work is included in WPs CPDY4, CPDY5, DA6, PH3, PH4)	RMI Belgium	1

WP objectives

This WP describes the coordination activities of the ALADIN Code Architect (CA). According to the Memorandum of Understanding, the CA shall technically assist the ALADIN PM in supervising the definition of the ALADIN System and the implementation of the ALADIN Canonical Model Configurations (CMC's).

Descriptions of tasks

Task	**Description**	**Participant abbrev.**	**Type of deliverable**
COM1.1.1	Follow the development of the Atlas library at ECMWF, and implement features that are required for LAM modeling	DaDe	Atlas-LAM branch (non-t-cycle)
COM1.1.2	Monitor evolution of ALADIN CMC's (AROME-Fr and ALARO-Cz), and their support in the mitraillette testing system.	DaDe	Cycle 45t1
COM1.1.3	Further implement and validate the use of the SURFEX surface scheme in the ALARO CMC. Develop a mitraillette test for this configuration. Backport fixes to cycles 40t1 and 43t2.	DaDe	Cycles 40t1, 43t2 and 45t1
COM1.1.4	Attend technical meetings between ECMWF, MeteoFrance, Hirlam and Aladin.	DaDe	(meetings)

t-code deliverables

Task	**Responsible**	**Cycle**	**Time**
COM1.1.2	DaDe	45t1	
COM1.1.3	DaDe	40t1, 43t2, 45t1	

Non-t-code deliverables

Task	**Responsible**	**Type of deliverable**	**Time**
COM1.1.1	DaDe	Code (non-t-cycle)	2018
COM1.1.4	DaDe	Meetings	~ 4 per year

ALADIN/HIRLAM/LACE WorkPackage description : COM1.2

WP number	Name of WP
COM1.2	HIRLAM Code analyst activities
WP main editor	**Jeanette Onvlee & Roel Stappers**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
RoSt	Roel Stappers	MET Norway	6

WP objectives

The aim is to develop and maintain the code architecture required to optimally implement upcoming scientific developments and code contributions from the work packages in chapter 3 into the common code for the data assimilation system (responsibility of the HIRLAM code analyst).

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
COM2.1	Attend technical meetings between ECMWF, MeteoFrance, Hirlam and Aladin.	RoSt	(meetings)
COM2.2	Define, and later monitor the evolution of, the common code for data assimilation and use of observations, initially for a basic data assimilation setup	RoSt	document
COM2.3	(Help) develop and promote the use of block unit tests for the LAM data assimilation components	RoSt	Tests, code for mitraillette
COM2.4	Propose technical solutions to implement LAM data assimilation algorithmic components and developments within the IFS/OOPS framework	RoSt	document
COM2.5	Document the design of the LAM data assimilation code and testing framework within the new IFS/OOPS code framework, and transfer knowledge on this to the ALADIN-HIRLAM community	RoSt	document, presentations

t-code deliverables

Task	Responsible	Cycle	Time
COM2.3	RoSt	CY46T?	End 2018?

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM2.2	RoSt	document	End 2018?
COM2.4	RoSt	document	End 2018?
COM2.5	RoSt	document, presentat	2018

ALADIN/HIRLAM/LACE WorkPackage description : COM2

WP number	Name of WP
COM2	Code generation and maintenance
WP main editor	Claude Fischer

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
GCO, ClFi, AlMa, KaYy, REK, PaSa, MFSci	GCO team, C. Fischer, A. Mary, K. Yessad, R. El Khatib, P. Saez, Météo-France scientific code experts as requested	Météo-France	92
ACNA, CA	ACNA and Code Architect (alreay included in other WPs)		
ASCS	LACE ASC	SHMU Slovakia	5.5
ACNA, CA, PHAS, ASCS	ALADIN phasers in Toulouse (1 FTE)	ALADIN (other than MF)	11
SAL, SET, DACA, HIRLAM-Sci	System Area Leader, System Experts team, DA Code Analyst, HIRLAM scientists	HIRLAM	12.5

WP objectives

This WP lists the major tasks necessary for preparing, building and validating new versions of the shared Aladin-Hirlam NWP System.
By essence, this work includes the efforts for building joint IFS/ARPEGE cycles (with ECMWF), since these cycles are the code bases of the so-called t-codes later.
The WP also includes those efforts dedicated to technical validation (aka sanity checks or "mitraillette") and preparation of new test programs, or making the test environment evolve.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
COM2-1	Build of new IFS/ARPEGE/LAM common releases, as defined in the ECMWF/Météo-France common trunk	GCO, ClFi, AlMa, KaYe, REK, PaSa, MFSci, PHAS, ASCS	t-code (complete)
COM2-2	Build of a T-cycle ARPEGE/LAM version, common to ALADIN and HIRLAM	GCO, ClFi, AlMa, KaYe, REK, PaSa, MFSci, PHAS, ASCS, SAL, SET, DACA	t-code (complete)
COM2-3	Cross-coordination aspects for planning timing and content of cycles (exchange of information, tele-meetings, preparatory documents)	ClFi, ACNA, SAL	docs
COM2-4	maintenance, further development and handover (to specific developers) of the code sanity check tools	KaYe, PaSa, AlMa, ClFi	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
COM2-1	ClFi	refer to timing of cycles	
COM2-2	ClFi	refer to timing of cycles	

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM2-3	ClFi, ACNA, SAL	documentation, communication	
COM2-4	KaYe, ClFi	scripts, data	

ALADIN/HIRLAM/LACE WorkPackage description : COM3.1

WP number	Name of WP
COM3.1	Support for maintenance and Partners' implementations of ALADIN system
WP main editor	**Maria Derkova**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MaDe	Maria Derkova	SHMU Slovakia	4
ClFi, AlJo, FrBo	Claude Fischer, Alain Joly, François Bouyssel	Météo-France	2.5

WP objectives

The aim of the WP is to support and coordinate the activities leading to implementation of new code version at the ALADIN Members' NMS; distribute relevant information among ALADIN Partners, collect the reported problems and their solutions and assist in preparation of code bugfixes; follow the contributions to new code releases. In parallel a coordination of operational changes between MF and ALADIN Partners is needed. Reporting to relevant bodies. Collaboration with MF, HIRLAM and RC LACE relevant persons.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
COM3.1.1	Supervision and coordination of local installation of new export version of the ALADIN code by ALADIN members. The work comprises communication with Meteo-France about the content and the schedule of new export version package of the ALADIN system; communication with (not only) LTMs about the progress of local installations of this code, encountered problems and their solution and reporting this to other Partners; collection and documentation of available fixes; reporting on the progress whenever relevant. Close collaboration with HIRLAM PL for SYSTEM and RC LACE ASC and MF contact point is an essential part of the activity.	MaDe	non-t-code (report)
COM3.1.2	Collection of reported problems from COM3.1.1 and their solutions and contribution to the preparation of the bugfix for the export code	MaDe	t-code
COM3.1.3	Preparation and chairmanship of the LTMs meetings	MaDe	non-t-code (meeting)
COM3.1.4	Coordination of operational changes with ALADIN Partners	ClFi, AlJo, FrBo	

t-code deliverables

Task	Responsible	Cycle	Time
COM3.1.2	MaDe (+ HIRLAM PL for system + RC LACE ASC)	CY43T2 bugfix (or on the cycle which is exported)	2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM3.1.1	MaDe	report	2/year @LTM meeting
COM3.1.3	MaDe	meeting	2/year @LTM meeting

ALADIN/HIRLAM/LACE WorkPackage description : CPDY1

WP number	Name of WP
CPDY1	Quasi-Elastic (QE) system
WP main editor	**Ludovic Auger**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
FaVo	Fabrice Voitus	Météo-France	3.5
KaYe	Karim Yessad	Météo-France	2.5

WP objectives

The purpose of that workpackage is to modernize the current dynamical core of ALADIN. One current concern is its stability, in particular related to steep orography that represents conditions for which the ALADIN-NH kernel seems to be less stable compared to its hydrostatic counterpart.Among the possible path to circumvent this drawback, the use of a class of alternative equations systems is currently explored at ECMWF and Météo-France. This class of equations was recently proposed (Arakawa and Konor, 2009,) and may be viewed as the minimal modification to the Euler equations (EE) system which allows a filtering of elastic waves. These systems have one less prognostic variable than the EE system, and therefore the pressure field is obtained through a diagnostic relationship. However, in opposition to anelastic systems, the approximation is not made around a stationary and horizontally homogeneous reference-state, but around a more general state close to the hydrostatic state. Theoretical work has been performed at Météo-France to derive a version of the quasi-elastic system adapted to our system of coordinates. That system appears to be more stable than the NH kernel. The current objective is to test that formulation inside our common code.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
CPDY1.1	Implementation of a quasi-elastic NH version of the ALADIN dynamcis in the common source code.The objective of that task is to implement in the ARPIFS-ALADIN code a preliminary quasi-elastic NH code containing at least vertical finite differences discretisation.This code will enter CY45T1 of ARPIFS-ALADIN, expected for the last term of 2017. Preliminary testings will be done, for example with AROME-500m resolution, in particular in cases where the fully elastic formulation exhibits some spurious oscillations or some instabilities above sharp slopes (Northern Alps).	FaVo, KaYe	t-code

t-code deliverables

Task	Responsible	Cycle	Time
CPDY1.1	KaYe	CY45T1	

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
CPDY1.1	FaVo	Documentation on the QE code	end of 2017

ALADIN/HIRLAM/LACE WorkPackage description : CPDY2

WP number	Name of WP
CPDY2	Development of methods for solving the implicit equation in gridpoint space.
WP main editor	**Ludovic Auger**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
LuAu, PiBe	Ludovic Auger, Pierre Bénard	Météo-France	12
ThBu	Thomas Burgot (ext)	Météo-France	11
JVB	Joris Van Bever	RMI Belgium	6
StCa, ThVe	Steven Caluwaerts, Thomas Vergauwen	RMI Belgium	4
JoVi	Jozef Vivoda	SHMU Slovakia	1

WP objectives

The current semi-implicit semi-lagrangian dynamical core of ALADIN is organized around its spectral nature, enabling some part of the computations like the solving of the implicit equation very efficiently. In order to lessen the impact of global communications inherent to 2D spectral transforms on the next generations of supercomputers, the task of this WP will be to test gridpoint alternatives to the spectral solver used today for the implicit equation. Another asset of a gridpoint solver technique is to be able to use a more complex basis state for the implicit system that could enable a better stability as regards steep slopes. This WP will adapt existing iterative solvers such as Krylov space solvers and make the necessary developments around aforementioned methods to replace the spectral solver of the implicit equation. The idea is to stick to the 2 time level, semi-implicit, semi-lagrangian algorithm on the A-grid.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
CPDY2.1	Feasibility of grid-point solver assessment. Implement different types of solvers into a 2D vertical plane model. The 2 subtypes of krylov solvers that might be the most appropriate for the implicit proablem are GMRES (Generalized Minimal Residual Method) and CONGRAD (CONjugate GRAdient method). The testing should be made with classical test cases. The use of different pre-conditionning strategies, different settings should be tested.	LuAu, StCa, ThVe	
CPDY2.2	Implementation of gridpoint solvers in the 3D code (scalability) We limit this WP to the hydrostatic equations and an explicit treatment of the orography to avoid a solver for 2 Helmholtz Eqs. (for d and D). (discussion : the implementation could be done nevertheless in NH, what workforce on that task ?)	LuAu, StCa, ThVe	
CPDY2.3	Develop a solver for an implicit orography treatment for the fully compressible system. The objective is to obtain a more stable system as regards steep slopes. This involves the solving of the implicit equation as a whole, without projection onto vertical modes. The use of a preconditioner will be mandatory to obtain efficiency.	LuAu	
CPDY2.4	Further developments of gridpoint discretizations on the sphere. The spherical coordinate system presents a singularity at the poles that results in some issues when performing computations (such as derivatives) on a regular grid. Using spectral space is a way to solve the problem. In gridpoint space careful computations must be performed. This task will continue the current investigations on proper gridpoint computations, by theoretical studies and by carrying on the development of a shallow water model to test the stability of the appropriate discretization for derivatives.	PiBe	

t-code deliverables

Task	Responsible	Cycle	Time
CPDY2.2			2018 or 2019

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
CPDY2.1	PiBe	Scientific publication	
CPDY2.3	PiBe	Scientific publication	
CPDY2.4	PiBe	Scientific publication	

ALADIN/HIRLAM/LACE WorkPackage description : CPDY3

WP number	Name of WP
CPDY3	Horizontally Explicit Vertically Implicit (HEVI) methods with ALADIN-NH core
WP main editor	**Ludovic Auger**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
FaVo	Fabrice Voitus	Météo-France	3.5
ChCo	Charles Colavolpe (ext)	Météo-France	5

WP objectives

The objective is to further study and assess the performance of HEVI strategies with the ALADIN-NH core.
The current ALADIN dynamical core is deeply constrained by its spectral nature. The gridpoint to spectral transforms performed at each time step allow to compute accurately the horizontal derivatives, and provide a very fast solving of the implicit equation. Consequently we are allowed to use long time steps. However, spectral transforms might become too expensive on the next generations of supercomputers architecture that should comprise hundreds of thousands of computational cores. The horizontally explicit vertically implicit (HEVI) schemes are an alternate successful time discretization strategy that treats implicitly only the terms involving vertical derivatives. Since the domain decomposition among computers nodes is performed only on the horizontal (grid cells belonging to the same vertical column are treated on the same node), HEVI schemes will require the minimum horizontal communications. Among the HEVI schemes the Runge-kutta implicit-explicit (IMEX) methods seem to present the most advantages. The Phd work of Ch. Colavolpe has investigated different formulations of HEVI schemes, a modified formulation of a RK-IMEX scheme improving its stability was successfully tested. These investigations have to be seen as a backup strategy if implicit techniques definitely fail, it is also a way to improve our knowledge on explicit techniques.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
CPDY3.1	Comparison of efficiency between a 3-TL SI-FD scheme and a 2-TL HEVI-FD scheme in a massively parallelized environment.That work involves the modification of the current HEVI test model that uses a 2D vertical plane geometry into a full 3D geometry. To be able to compare the scalability of the HEVI scheme, a full MPI/open-MP configuration must be set-up with an efficient computation of the different components in order for the computations not to artificially improve the scalability of the model. The comparison will be made to the AROME full operational code, running in an adiabatic configuration as close as possible to the HEVI model.	FaVo, ChCo	
CPDY3.2	Improving the stability of HEVI scheme with a implicit treatment of some metric terms coming from the orography.The current HEVI configuration under test seems to present the same instabilities than the SI-SL ALADIN core as regards forecast in a steep slopes environment.That task first requires theoretical work in order to understand the link between the bottom boundary conditions and the instabilities.	FaVo, ChCo	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
CPDY3.1	FaVo	Scientific paper with a toy model	
CPDY3.2	ChCo	Scientific paper with a toy model	September 2017

ALADIN/HIRLAM/LACE WorkPackage description : CPDY4

WP number	Name of WP
CPDY4	Physics-dynamics interface
WP main editor	**Daan Degrauwe**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PaMa, FaVo	Pascal Marquet, Fabrice Voitus	Météo-France	3
DaDe	Daan Degrauwe	RMI Belgium	2

WP objectives

The physics-dynamics interface of an NWP model determines how contributions from physical parameterizations affect the prognostic variables of the model. As such, it plays a crucial role in the conservation properties of the model, as well as in the consistency of the framework of thermodynamic simplifications and assumptions.The goal of this work package is to further explore the possibility to derive the energy equation of our models (IFS/ARPEGE/ALADIN/MESO-NH) without relying on the entropy budget, so relying only on the first principle of thermodynamics. This could reinforce the physical foundation of the set of equations. Another possible outcome is the identification of thermodynamic inconsistencies between the dynamics equations and the physics-dynamics interface.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
CPDY4.1	Explore possibility to derive the energy equation without relying on the entropy budget.	PaMa	Documentation
CPDY4.2	Investigate the consistency between thermodynamic simplifications in dynamics and physics-dynamics interface. Examples are: the treatment of humidity in the dynamic equations, and the filtering of the dynamic equations (anelastic/quasi-elastic/compressible).	PaMa, FaVo	Documentation
CPDY4.3	Implement and test outcomes of DY4.1 and DY4.2 in ALADIN.	DaDe	Code in t-cycle

t-code deliverables

Task	Responsible	Cycle	Time
CPDY4.3	DaDe		Autumn 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
CPDY4.1	PaMa	Documentation	Spring 2018
CPDY4.2	PaMa	Documentation	Spring 2018

ALADIN/HIRLAM/LACE WorkPackage description : CPDY5

WP number	Name of WP
CPDY5	Development of LAM components in Atlas
WP main editor	**Daan Degrauwe**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
DaDe	Daan Degrauwe	RMI Belgium	3
JVB	Joris Van Bever	RMI Belgium	ESCAPE

WP objectives

Atlas is a framework being developed at ECMWF for the handling of data structures in parallel, distributed or heterogeneous hardware environments. Given the link between the code of ECMWF's IFS model, and the codes in the ALADIN-HIRLAM universe, it is necessary that the Atlas framework also supports limited-area models. Even though the introduction of Atlas in the IFS is not foreseen for the immediate future, it is best to anticipate this situation and introduce LAM-awareness in Atlas already during the early design stage.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
CPDY5.1	Introduction of LAM variants of the (projected) grid and mesh classes in Atlas.	DaDe, JVB	Code on ESCAPE git-repository
CPDY5.2	Impact of projection (map factors and compass) on numerical operators like finite-volume derivatives.	DaDe, JVB	Code on ESCAPE git-repository
CPDY5.3	Atlas (C++) interface to the LAM spectral transforms (“etrans”).	DaDe, JVB	Code on ESCAPE git-repository
CPDY5.4	Run ESCAPE dwarfs (e.g. sparse solver GCR) in LAM configuration.	DaDe, JVB	Code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
CPDY5.1	DaDe	Put code in git-repository of the ESCAPE project. Atlas will become publicly available at the end of this project.	Summer 2017
CPDY5.2	DaDe	Put code in git-repository of the ESCAPE project. Atlas will become publicly available at the end of this project.	End of 2017
CPDY5.3	DaDe	Put code in git-repository of the ESCAPE project. Atlas will become publicly available at the end of this project.	End of 2017
CPDY5.4	DaDe	Put code in git-repository of the ESCAPE project. Atlas will become publicly available at the end of this project.	End of 2018

ALADIN/HIRLAM/LACE WorkPackage description : CPDA1

WP number	Name of WP
CPDA1	Core programme Basic data assimilation setup
WP main editor	**Piet Termonia, Alena Trojakova**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MSG, MaKo	Malgorzata Szczech-Gajewska, Marcin Kolonko (2.5, 1.5)	IMGW Poland	4
AnSa	Anis Satouri	INM Tunisia	2
MaMo	Maria Monteiro	IPMA Portugal	5
	t.b.d. by the DA coordinator	Maroc Meteo	1
TaDa, DuAk, MeSe, AlGu	Tayfun DALKILIC, Duygu AKTAS, Meral SEZER, Alper GUSER (2, 2, 2, 2)	MGM Turkey	8
AnBo,DeBa	Andrey Bogatchev, Denitsa Barakova (2, 2)	NIMH Bulgaria	4
IdDe	Idir Dehmous	ONM Algeria	1
AlDe	Alex Deckmyn	RMI Belgium	3

WP objectives

The objectoves of this program are

1. to develop a cross-consortia coordination to help all ALADIN and HIRLAM NMS's that wish to apply data assimilation operationally, to set up a basic 3D-Var data assimilation cycle with a (limited) set of observation data.
2. While doing so, define the required codes and build a list of ALADIN-HIRLAM common codes for the basic data assimilation configuration. This can include codes for the assimilation algorithms and for observation processing, and scripts to run the data assimilation cycles.

The programme is still under construction. **The first conditional step to be taken is to hire a data assimilation coordinator with a track record in data assimilition.**

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
CPDA1.1	**Data acquisition:** As a starting point, arrangements have to be made for local acquisition of GTS conventional data. An overview should be prepared of additional local non-GTS synoptic observations and/or other conventional data such as upper air soundings, wind profilers and aircraft observations available for routine assimilation (including data format and the possible need for local data conversion to BUFR format).	All	
CPDA1.2	**Data pre-processing:** GTS SYNOP data contain duplications (corrections/amendments messages), and given observations can be disseminated in several GTS messages. Data pre-processing should ensure that duplications are removed from the data sample, and may comprise a basic quality control (completeness, …).	All	
CPDA1.3	**Implementation and validation of BATOR:** The data assimilation system software requires observations in ODB format. A tool for data conversion is to be installed and validated (BATOR). Besides data conversion, BATOR performs blacklisting, geographical selection, setting up of observation errors, etc. When BATOR is functioning, the ingest of the acquired and pre-processed observations in BATOR can be tested.	All	
CPDA1.4	**Setup of observation monitoring:** An observation monitoring system is an essential part of any data assimilation system. The main objective is to provide an informative selection of monitored parameters (statistics of availability and quality control (QC) status, time evolution of satellite biases, etc.). A local implementation of tools to inspect/extract ODB information (odbsql) is essential. Eventually a more advanced system/tool is desirable.	All	
CPDA1.5	**Setup of a cycling system:** The cycling in assimilation is generally arranged in a script system. For this, the Harmonie scripting or a part of it may be used, but also simpler cycling scripts used with LACE.	Be, Pt, Tn, Tk	

CPDA1.6	**Definition of the basic data assimilation configuration:** The aim is to define and document the common code required for the basic data assimilation configuration, as a starting point for extending the CMC concept to the data assimilation system. This will be done by the HIRLAM code analyst for data assimilation. At a later point, (a limited number of) more advanced data assimilation configurations can be defined additionally, involving e.g. flow-dependent assimilation algorithms and a wider range of (non-conventional) observations. A list will be drawn up of all the codes and scripts for observation pre-processing, monitoring, cycling and data assimilation used in this basic data assimilation configuration. The monitoring of the evolution of this list, as well as the development of sanity tests for different parts of the data assimilation system, in order to check the validity of the basic data assimilation configuration from cycle to cycle, will be done in the context of WP COM1 in the future.	All	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
CPDA1.1	MM	code and technical note	End 2017?
CPDA1.2			End 2017?
CPDA1.3			End 2018?
CPDA1.4			End 2019?
CPDA1.5			End 2019?
CPDA1.6			End 2018?

ALADIN/HIRLAM/LACE WorkPackage description : DA1

WP number	Name of WP
DA1	Further development of 3D-Var (alg. Settings)
WP main editor	**Roger Randriamampianina, Máté Mile, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
CaGe,JaSa	Carlos Geijo, Jana Sanchez (6, 3)	AEMET Spain	9
AlTr, PaBe, AnBu, RaBr	Alena Trojakova, Patrik Benacek, Antonin Bucanek, Radmila Brozkova	CHMI Czech	6
AnSt, KrHo	Antonio Stanesic, Kristian Horvath (3, 1.5)	DHMZ Croatia	4.5
XiYa, MDah	Xiaohua Yang, Mats Dahlbom (CARRA, 2)	DMI Denmark	2, CARRA
WaKh	Wafa Khafaoui	INM Tunisia	1
RoAz, OlVi, RoRa	Roohollah Azad, Ole Vignes, Roger Randriamampianina (NowWind, NowWind, CARRA)	MET Norway	NowWind, CARRA
MiPi	Mirela Pietrisi	Meteo Romania	2
PiBr, ClFi	Pierre Brousseau, Claude Fischer (5, 0.5)	Météo-France	5.5
MaMi	Mate Mile	OMSZ Hungary	0.5
MaLi, MaRi,NiGu	Magnus Lindskog, Martin Ridal, "NewP" (2 SEA/CARRA, 2.5 MetCoOp, 1)	SMHI Sweden	5.5 SEA/CARRA, MetCoOp
FlMe	Florian Meier	ZAMG Austria	2

WP objectives

Refine and optimize the 3D-Var system in several ways:
- improve the realism of structure functions and the sampling of uncertainty; assess alternative ways of generating structure functions and the validity of the assumed balances.
- seek ways to reduce the fast evolution of small-scale noise which is often seen in analysis increments. Compare different background error statistics formulations (estimated using downscaling, EDA, with and without large scale mixing) with respect to the balance between control variables and the increments evolution in the first 2h of model integration. Explore the impact of initialization by applying the incremental analysis update (IAU) scheme, the back and forth nudging scheme (Auroux et al. 2005, 2011), and also by considering the variational technique encoded in a non-hydrostatic model operator in building the balance between control variables in data assimilation.
- study the most effective way to use large scale information from the host model.
- study optimal ways to account for scales of observations and the need of super-obbing/thinning in observation space or averaging in model space.
- Tune the overall assimilation system in terms of bias corrections, thinning strategy, observation and background error statistics, assimilation frequency and analysis resolution.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DA1.1	High-resolution observations:optimize structure functions generation for assimilation of high-resolution data (sampling on appropriate scales, spectral spin-up, impact of imbalances and numerical noise); evaluate scales of variability in mesoscale phenomena; investigate the effective model resolution, optimal scales for super-obbing and meaningful scales for analysis updates; develop methodology to account for correlated observation errors and to allow re-linearization, spatial averaging and integration “along a path”.	MaLi (2), MaRi (2.5), CaGe (3), RoRa& RoAz (RadPrO), JaBa, JaSa (3), WaKh	Code and scientific note
DA1.2	Background error statistics: Evaluate the impact of different formulations of the background error statistics (e.g. downscaled, EDA, large scale mixing or not) on the balance between control variables and on spinup.	CaGe, RoRa, AnSt, KrHo, MaMi	Scientific note
DA1.3	Initialization techniques: compare the available tools (DFI, IDFI, SSDFI and IAU), further develop the back and forth nudging in the Harmonie system, and consider the variational technique encoded in a non-hydrostatic model operator in building the balance between control variables in data assimilation.	OlVi, JaSa, MiPi, FlMe, CaGe (5)	Code and scientific note
DA1.4	Large scale information: Compare various mechanisms for taking the large scales into account (Jk, LSMIX,…). Consider increased lateral boundary condition coupling frequency.	MDah (2), XiYa	Scientific note
DA1.51-2	Observing system simulation experiment: 1)Adapt the Harmonie data assimilation system for OSSE experiments. 2)Adapt the environment of Observing System Simulation Experiments with the AROME 3D-Var to a more recent code cycle.	RoRa	Scientific note
DA1.6	Maintenance and evolution of Arome-France 3D-Var: follow-on changes of e-suites at MF, exchange about scientific results with other Aladin and Hirlam partners.	PiBr, ClFi	Scientific note
DA1.7	3h cycling appropriate for BlendVAR	AlTr, PaBe, AnBu, RaBr	
DA1.8	B-matrix appropriate for BlendVAR	AnBu	

t-code deliverables

Task	Responsible	Cycle	Time

DA1.2	OV: New and/or updated codes for back and forth nudging	Earliest CY46T1	end 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA1.1	MaRi	Scientific note	end 2018
DA1.2	CaGe: New and/or updated codes for variational non-hydrostatic balance	codes changes earliest CY46T1	end 2018
DA1.2	MaMi	Scientific note	end 2018
DA1.3	OlVi, JaSa, CaGe	Scientific note	mid-2018
DA1.4	MDah, XiYa	Scientific note	End of 2018
DA1.5	RoRa	Scientific note	End of 2018
DA1.6	PiBr, ClFi	Technical report	End of 2018

ALADIN/HIRLAM/LACE WorkPackage description : DA2

WP number	Name of WP
DA2	Development of flow-dependent algorithms
WP main editor	**Roger Randriamampianina and Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PaEs,CaGe	Pau Escriba, Carlos Geijog (4, 2)	AEMET Spain	6
XiYa	Xiaohua Yang	DMI Denmark	0.25
WaKh	Wafa Khafaoui	INM Tunisia	1
JaBa	Jan Barkmeijer	KNMI Netherlands	3
RoSt, RoRa	Roel Stappers, Roger Randriamampianina (ERA6, RadPrO)	MET Norway	ERA6, RadPrO
LoBe, BeMe, YaMi, ThMo, PiBr, EtAr, CeLo	Loik Berre, Benjamin Ménétrier, Yann Michel, Thibaut Montmerle, Pierre Brousseau, Etienne Arbogast, Cécile Loo (6.5, 8.5, 8, 8, 2, 3, 4)	Météo-France	40
JeBo, NiGu, MaLi	Jelena Bojarova, Nils Gustafsson, Magnus Lindskog (3, 3, 2)	SMHI Sweden	8

WP objectives

Various approaches are being pursued to introduce flow-dependency into the data assimilation:
4D-Var, 3D-Var/LETKF, and hybrid EnVar algorithms as described in Desroziers et al. (2014).
HIRLAM will further assess the potential of 4D-Var, examining e.g. the limitations due to the difficulties in representing non-linear processes and optimal settings of the assimilation window. Planned developments include the impact assessment of more high-density data sources, the evaluation of weak constraint DFI, and the application of multiple outer loops.
The 3D-Var/LETKF scheme will be developed further. The use of more observations with different localization settings will be studied with the aim to optimize the sampling methodology to most effectively extract local information from the ensemble of perturbations.
A 3/4DEnVar approach should be able to handle complex non-linear processes more realistically than 4D-Var, while having lower computational costs and better scalability. HIRLAM and Meteo-France are working on somewhat different approaches for this. MF is developing a 3D/4DEnVar system from scratch in the framework of the OOPS system. The scientific formulation is based on the various versions described in the theoretical approach of Desroziers et al. (QJ, 2014). These formulations are derived in a parallel manner for the global and LAM contexts. Upcoming work concerns the improvement of localization and advection schemes in EnVar, tests using as feasible most of the operational-like observation types, assessment of the levels of scalability and optimization within the algorithms. Hybrid 3D/4D-Var and EnVar solutions (as feasible within the OOPS layer) will be addressed. The HIRLAM approach is based on the work on 3- and 4-EnVar which has been done earlier within the HIRLAM model (e.g. Gustafsson and Bojarova 2014). Tuning of the balance constraint in the minimizaion will be addressed, as well as the design of the hybrid gain environment.
MF will further develop and improve their Ensemble data assimilation configurations (EDA): AEARP for the global model and AEARO for the Arome-France CMC. The EDA states are injected among the initial condition perturbations of the global and LAM EPS systems (PEARP, PEARO). The additional benefit of using EDA-derived statistics of-the-day within 4D-Var (Arpège) and 3D-Var (Arome-France) will be addressed.
It is important to carefully coordinate and time these envisaged developments with respect to the code overhaul in the context of OOPS, in collaboration between global and LAM partners.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DA2.1	4D-Var: investigate error propagation and predictability limits (linear regime of development, impact of moist physics, energy growth saturation); re-address initialisation; optimize 4D-Var configuration (length of assimilation and observation windows, increment resolution, ODB update in outer loops); address the convergence issue in the variational scheme; investigate ways to improve 4D-Var computational performance and scalability; Exploit the benefit of tendency increments.	NiGu, JaBa, JeBo (3), MaLi(2), RoSt, RoRa	Code and scientific note
DA2.2	3D-Var/LETKF: investigate alternative hybrid formulations ("Kalman gain"/"alpha control variable"); compare different ensemble generation techniques with regards to affordable ensemble size, lagging strategy, sampling of "model error" uncertainty, and EPS properties.	JeBo, RoRa, PaEs (4)	Code and scientific note
DA2.3	EnVar in OOPS: improve scientific options (localization, advection), test cases, update as feasible for using operational-like observations and with respect to refactored IFS Cycles, assess scalability and optimization; assess the performance of the statistical balance constraint in the minimisation, Design the hybrid gain environment.	LoBe, BeMe, CeLo, EtAr, YaMi, ThMo, PiBr	code and scientific notes
DA2.4	EDA: 1) AEARP and AEARO: scientific improvements in both EDA systems, increase of horizontal resolutions in AEARP, e-suite testing of AEARO; 2) Continue the tuning the evaluation of the Harmonie EDA performance with different model resolutions.	LoBe, BeMe, CeLo, YaMi, ThMo, PiBr, RoRa	code and scientific notes
DA2.5	Use of Ensemble DA information in the AROME-France 3D-VAR assimilation system.	YaMi, PiBr	code and scientific notes
DA2.6	Further development of the Field Alignment technique, also in the context of 4D-Var.	CaGe (2), RoRa	code and scientific notes

t-code deliverables

Task	Responsible	Cycle	Time
DA2.1	JeBo, RoSt	CY47 or later	end 2018

DA2.2	JeBo, PaEs	CY47 or later	end 2018
DA2.3	MF involved staff	CY47 or later	2017-+
DA2.4	LoBe, YaMi	CY45T1 through CY46T1	2017-2018
DA2.5	YaMi, PiBr	CY45T1 or CY46	2017 or 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA2.1	MaLi	update of 4D-Var script and namelists	end 2018
DA2.2	JeBo	update of Harmonie script and namelists	end 2018
DA2.3	MF scientific staff	scientific papers about progress with OOPS/EnVar	end 2018
DA2.4	1) MF scientific staff; 2) RoRa	1)scientific papers, namelists for the MF suites; 2)script update for Harmonie	end 2018
DA2.5	MF scientific staff	scientific papers or notes, OLIVE scripting adaptations	end 2018

ALADIN/HIRLAM/LACE WorkPackage description : DA3

WP number	Name of WP
DA3	Use of existing observations
WP main editor	**Roger Randriamampianina, Jean-François Mahfouf**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
JoCa, MaDi, Jasa, AnHe	Joan Campins, Maria Diez, Jana Sanchez, Angeles Hernandez (2, 4, 4, 3)	AEMET Spain	13
BeSt, PeSm	Benedikt Strajnar, Peter Smerkol (7, 2)	ARSO Slovenia	9
AnBu, PaBe, AlTr	Antonin Bucanek, Patrik Benacek, Alena Trojakova	CHMI Czech	17
AnSt, ToKo	Antonio Stanesic, Tomislav Kovacic (2, 4)	DHMZ Croatia	6
MaDa, HeVe	Mats Dahlbom, Henrik Vedel (2, 1)	DMI Denmark	3
TuPe, ErGr	Tuuli Perttula, Erik Gregow (?, 2)	FMI Finland	2
SiTh	Sigurdur Thorsteinsson	IMO Iceland	4.5
AnSa, WaKh	Anis Satouri, Wafa Khafaoui (2, 1)	INM Tunisia	3
IsMo, MaMo	Isabel Monteiro, Maria Monteiro (2, 2.5)	IPMA Portugal	4.5
SdH, WiVe, GJM, JaBa	Siebren de Haan, Wim Verkleij, Gert-Jan Marseille, Jan Barkmeijer (1?, 3, 3, 1)	KNMI Netherlands	7 +1?
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui (5, 5)	Maroc Meteo	10
EoWh	Eoin Whelan	MET Eireann	2
RoAz, TeVa, RoRa	Roohollah Azad, Teresa Valkonen, Roger Randriamampianina	MET Norway	CARRA, RadPrO
AlDu	Alina Dumitru	Meteo Romania	2
FrGu, NaFo, ViGu, PaMo, ViPo, ErWa, ImFa	Frank Guillaume, Nadia Fourrié, Vincent Guidard, Patrick Moll, Vivien Pourret, Eric Wattrelot, Imane Farouk (3, 3.5, 3.5, 4, 4.5, 4, 6)	Météo-France	28.5
DuUs, YeCe	Duygu Ustuner, Yelis Cengiz (2, 2)	MGM Turkey	4
MaMi, MaMe	Mate Mile, Mate Mester (4, 6)	OMSZ Hungary	10
IdDe	Idir Dehmous	ONM Algeria	1
MiNe, MaIm	Michal Nestiak, Martin Imrisek (4, 3)	SHMU Slovakia	7
MaLi, MaRi, GuHa	Magnus Lindskog, Martin Ridal, Günther Haase (1 CARRA/METCOOP, 4, 1)	SMHI Sweden	6, CARRA, METCOOP
FlMe, JoKe	Florian Meier, Jozef Kemetmuller (2, 2)	ZAMG Austria	4

WP objectives

In the past years various types of high-resolution observations have been made available in the assimilation system and found to positively impact forecast quality, such as radar reflectivities, GNSS ZTD, Mode-S, ASCAT winds, AMVs, and satellite radiances. It is a high priority task to ensure that these observations become available operationally to as many members as possible.
For observation types already available in the assimilation system, ways are being investigated to optimize their use with regard to quality control, thinning/super-obbing, the size of their footprint with respect to the modelled values, and bias correction. For radar data, quality control investigations will remain a point of attention.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DA3.1	Radar data: optimize radar assimilation, prepare for operational introduction; continue to harmonize and improve quality control procedures and pre-processing (intelligent thinning / super-obbing); test alternative velocity de-aliasing algorithms and provide feedback to OPERA; generalize radar assimilation to 4D-Var and later to hybrid systems; impact studies to assess value of radar data in different weather regimes. Finalize the adaptation of BATOR to radar Doppler winds and reflectivities from OPERA. Perform monitoring and assimilation of various European radars.	AnSt, ToKo, FlMe, MiNe, AlDu, MaMe, MaDa (2), MaRi (3), WiVe (3), TuPe, RoAz, GuHa (1), AlTr, FrGu, ErWa, ZaSa (2), JaBa (1), JaSa (2), IdDe	T-codes and scientific note
DA3.2	Aircraft-derived data (ADD): implement Mode-S pre-processing; refine quality control, thinning/super-obbing; evaluate VarBC for ADD; impact assessment.	BeSt, AnBu, PaBe, JK, SdH, EoWh, RoRa, AlTr, BeSt, FlMe, PaBe, FrGu, ViPo, PaMo, MaRi (1)	T-codes and scientific note
DA3.3	Ground-based GNSS ZTD: optimize assimilation of ZTD data; refine white- or blacklisting of GNSS stations and use of VarBC; conduct impact study; apply with 4D-Var.	JaSa (2), SiTh (2), MaLi (0.5), PaMo, MaMi, MaIm, FaHd	T-codes and scientific note
DA3.4	Scatterometer winds: optimize settings for update frequency, thinning/accounting for footprint size in first-guess departure (supermodding), correlated observation errors, and assess impact in different weather regimes;	TeVa, GJM (3), BeSt, IsMo	T-codes and scientific note

DA3.5	AMV: Implementation of locally generated AMV's (NWCSAF HRW software); elaborate the blacklisting procedure.	FM, BeSt, MMi, AlTr, EoWh (0.5), ErGr (2), TL	T-codes and scientific note
DA3.6.1-3	Clear-sky radiances: 1) Seviri, 2) IASI and CrIS, and 3) ATOVS and ATMS: improve the estimation of surface emissivity and skin temperature to allow their assimilation over sea ice and land, including radiances from low-peaking channels.	PaBe, MaMo, MaDa, TuPe, SiTh (2.5), MaDi JoCa (2), WaKh, DuUs, YeCe	T-codes and scientific note
DA3.7	Cloud-affected radiances: IASI and CrIS radiances: allow assimilation of cloud-affected radiances (e.g. CO2 slicing).	TuPe, ViGu, NaFo, ImFa	T-codes and scientific note
DA3.8	Near-surface observations in the upper air assimilation: refine vertical interpolation, quality control, VarBC; perform impact assessment; promote data exchange between NMS's.	MaLi (0.5), MaRi MaDi	T-codes and scientific note
DA3.9	Radiosondes: optimize pre-processing, extend observation operator, assess impact of high- resolution BUFR data, and promote their use.	AlTr, EoWh (0.5),AnSa, MaMo, DuUs, YeCe	T-codes and scientific note.

t-code deliverables

Task	Responsible	Cycle	Time
DA3.1	MaDa	CY46T1 or later	end 2018
DA3.2	EoWh, RoRa, PM	CY46T1 or later	end 2018
DA3.3	MaLi, JAnSa, PaMo	CY46T1 or later	end 2018
DA3.4	GJM	CY46T1 or later	end 2018
DA3.5	EoWh, RoRa	CY46T1 or later	end 2018
DA3.6.1	PaBe, MaDi	CY46T1 or later	end 2018
DA3.6.2	SiTh, RoRa	CY46T1 or later	end 2018
DA3.6.3	MaDa	CY46T1 or later	end 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA3.1	MaMo	Scientific note	end 2018
DA3.4	IsMo	Scientific note	end 2018
DA3.7	TuPe	Report and scripts and namelist update	end 2018
DA3.8	MaLi	Report and scripts and namelist update	end 2018

ALADIN/HIRLAM/LACE WorkPackage description : DA4

WP number	Name of WP
DA4	Use of new observations types
WP main editor	**Jean-François Mahfouf and Roger Randriamampianina**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PaBe	Patrick Benacek	CHMI Czech	1
KaHi	Kasper Hintz	DMI Denmark	6
CdB, SdH, JaBa	Cisco de Bruijn, Siebren de Haan, Jan Barkmeijer (2,2?,HowObs?)	KNMI Netherlands	4?, HoiwObs?
FaHd	Fatima Hdidou	Maroc Meteo	0.5
MaDi	Maria Diez	AEMET Spain	1
RoRa, RoAz, RoSt	Roger Randriamampianina, Roohollah Azad, Roel Stappers (ALARTNESS?, PRODEX, HowObs?)	MET Norway	ALARTNESS?, PRODEX, HowObs?
PaMo, ErWa, FrGu, ViGu, NaFo, PhCh, FaDu, ViPo, ChPa, JFM, FrVi, ZiSa, GuTh	Patrick Moll, Eric Wattrelot, Frank Guillaume, Vincent Guidard, Nadia Fourrié, Philippe Chambon, Fabrice Duruisseau, Vivien Pourret, Christophe Payan, Jean-François Mahfouf, Francesca Vittorioso, Zied Sassi, Guillaume Thomas (2, 4, 1.5, 4.5, 3.5, 5.5, 11, 6.5, 4.5, 1, 8, 11, 11)	Météo-France	74
YaLa, MOAM	Yasmine Lamari, Mohand Ouali Ait Meziane (1, 1)	ONM Algeria	2
FlMe	Florian Meier	ZAMG Austria	0.5

WP objectives

The general goal is to prepare the use of new (not yet routinely available in the LAM DA system) observations in the various LAM variational data assimilation systems (for current 3D/4D-Vars and future 3D/4D-En-Vars). The quality of mesoscale analyses rely on an efficient extraction of small-scale information contained in data available at high spatial and temporal scales. The priority should be on observations that can help to constrain the model evolution in terms of water vapour, clouds and precipitation. In order to make an optimal usage of the various data types, significant activities should be devoted to the specification of quality controls (e.g. cloud detection for satellite radiances), error specifications, bias corrections and data sampling/averaging.

Descriptions of tasks

Task	Description	Participantabbrev.	Type of deliverable
DA4.1	All-sky radiances: 1) Implement the use of all-sky radiances starting with ATOVS and SSMI/S (ECMWF method). 2) Finalise the design of the assimilation of “all-sky” microwave radiances using a Bayesian inversion in the AROME 3D-Var (MF method). 3) Use the RTTOV-SCATT radiative transfer model for the quality control of microwave radiances before assimilation in the AROME 3D-Var.	RoRa, RoAz, FaDu, PhCh, JFM, YaLa	Codes and scientific note
DA4.2	GNSS slant delay:finalise the observation operator, conduct impact study	SdH	Codes and scientific noe
DA4.3	GNSS ZTD horizontal gradients: Finalise the coding of the observation operator, conduct impact study with data provided by IGN.	PaMo, FaHd, FrGu	Codes and scientific note
DA4.4	High-resolution surface pressure observations: explore potential of volunteered observations from crowd and smartphones.	RoSt, KaHi, JaBa	Codes and scientific note
DA4.5.1-4	Future satellite instruments: Preparations for assimilation of, respectively, 1) Aeolus L2 HLOS winds, 2) MTG-IRS, 3) IASI-NG, 4) winds from various scatterometers.	RoAz, ViGu, FruG, ViPo, ChPa, FrVi	Codes and scientific note
DA4.6	The use of AMDAR humidity observations: Monitor, optimize the QC and perform impact study of AMDAR humidity in the ALARO/AROME 3D-Var.	PaBe, FlMe, MaDi (1), PaMo, MOAM	Code and scientific note
DA4.7	Assimilate L2 profiles of temperature and humidity derived from IASI and ATOVS radiances (produced by EUMETSAT) in the AROME 3D-Var.	ViGu	Scientific note
DA4.8	Document the assimilation of IASI reconstructed radiances from PC scores in the AROME 3D-Var (preparatory studies for the assimilation of data from IRS/MTG).	NaFo, ViGu	Scientific note
DA4.9	Assimilate wind data from recreational hot-air balloon flights in HARMONIE-AROME 3D-VAR	CdB (2)	Code and Scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA4.1	1) RoRa, 2-3) PhCh	CY46T1 or later	end of 2018
DA4.2	SdH	CY46T1 or later	end 2017
DA4.3			
DA4.4	KaHi	CY47T1	End of 2018
DA4.5.1-4	1-RoAz, FrGu	CY47T1	End of 2018
DA4.6	MaDi, PaMo	CY47T1	End of 2018
DA4.7	ViGu	CY47T1	End of 2018
DA4.8	NaFo	CY47T1	End of 2018

DA4.9	CbB	CY46T1	Middle of 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA4.1	RoRa	CY43	end of 2018
DA4.7		Technical report	End of 2018
DA4.8	AlTr, FlMe	Technical report	End of 2018
DA4.9		Technical report	End of 2018

ALADIN/HIRLAM/LACE WorkPackage description : DA5

WP number	Name of WP
DA5	Development of assimilation setups suited for nowcasting
WP main editor	**Roger Randriamampianina, Xiaohua Yang, Pierre Brousseau, Florian Meier**

Table of participants

Participant Abbrevia	Participant	Institute	PersonMonth or External project
CaGe	Carlo Geijo	AEMET Spain	1
BeSt	Benedikt Strajnar	ARSO Slovenia	3
XiYa, ClPe, HeVe	Xiaohua Yang, Claus Pedersen, Henrik Vedel (1,?,0.4)	DMI Denmark	1.5
ErGr	Erik Gregow	FMI Finland	2
MaMo	Maria Monteiro	IPMA Portugal	1
SdH	Siebren de Haan	KNMI Netherlands	1?
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui (3, 3)	Maroc Meteo	6
RoAz, RoRa	Roohollah Azad, Roger Randriamampianina (Flyvær, RadPrO)	MET Norway	Flyvær, RadPrO
MiPi	Mirela Pietrisi	Meteo Romania	2
PiBr	Pierre Brousseau	Météo-France	1
MiNe, MaDi	Michal Nestiak, Martin Dian (2, 2)	SHMU Slovakia	4
MaLi, ToLa	Magnus Lindskog, Tomas Landelius (SEA)	SMHI Sweden	SEA
FlMe, PhSc, FlWe	Florian Meier, Phillip Scheffknecht, Florian Weidle (1.5, 2, 1)	ZAMG Austria	4.5

WP objectives

Nowcasting and very short range forecasting (~2-6h) require rapid and frequent updating of the model initial state with the most recent (and frequent) observations. 3D-Var nowcasting setups with hourly or even sub-hourly cycling are being experimented with. Because of their high time frequencies, observations from radars, GNSS, geostationary satellites, aircraft, polar orbiting satellites for high latitude domains, and surface networks provide relevant observational input data. The problem of how to account for spatially and temporally correlated observation errors in the analysis of these data needs to be tackled. Ways to reduce model spinup and optimizing cycling and initialization strategies in the nowcasting range will be considered. Several methods are being developed with the aim of giving greater weight to observations, in particular radar data and cloud satellite imagery. Nudging techniques are being considered within LACE. In HIRLAM, the cloud initialization technique (using satellite imagery to initialize model humidity fields) will be applied to a wider range of cloud products from the SAF/NWC. At high resolutions, it becomes increasingly important for the analysis system to correct for displacement errors in fine-scale atmospheric features. The field alignment and image warping techniques, developed to identify and correct for displacement errors with respect to e.g. radar data or satellite imagery, will be integrated into the variational assimilation system. Nested (sub-kilometric) models with or without data assimilation will be, as well, tested. For the method to have optimal effect, alternative formulations of balance may be required; this is being investigated in WP DA1.2.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DA5.1	Observation networks suitable for RUC/RR setup: monitor observations usage; evaluate quality, promote data exchange from local observation networks.	SdH, HeVe, ErGr (0.5), FlMe, BeSt, MiNe, MaMo, ZaSa, FaHd	Codes and scientific note
DA5.2	Assimilation cycling strategy: evaluate aspects of assimilation setup updating frequency, rapid refresh (RR) vs RUC. Test of rapid refresh with use of moving assimilation window and assimilation cycling with overlapping windows.	RoRa, XiYa, PiBr, ZaSa, FaHd	Codes and scientific note
DA5.3	Treatment of non-additive errors: further develop the integration of field alignment (FA) into variational data assimilation. Consider the alternative of “assimilating” the FA output using the variational constraint developed under DA1.3.	CaGe, RoRa	Codes and scientific note
DA5.4	Towards cloud initialisation: initialize humidity fields from CPP products and evaluate their impact on the cloud initialization; study pre-conditioning of the first guess using radar data. Study weather regime dependent balances between hydrometeor model variables and control state variables, possibly using ensemble techniques.	ErGr (1), MaLi (2), ToLa, FlWe, FlMe, MiNe	Codes and scientific note
DA5.5	Optimize setup for nowcasting range: optimize design and implementation of a data assimilation system suitable for the very short range (0-6h). Test of combination of upper air 4DVAR or 3DVAR for coarse resolution domain with internally nested high resolution downscaling using radar data nudging).	RoAz, XiYa (1), ErGr (0.5), ClPe, FlMe, PhSc, MiNe, MaDi, MiPi	Codes and scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA5.4	ErGr	CY45	end 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA5.1	SdH	script and code	end of 2018
DA5.2	RoRo, XiYa, PiBr	script and code	end of 2018
DA5.3	CaGe, RoRa	script and code	end of 2018
DA5.5	RoAz, XiYa	script and code	end of 2018

ALADIN/HIRLAM/LACE WorkPackage description : DA6

WP number	Name of WP
DA6	Participation in OOPS
WP main editor	**Claude Fischer, Roel Stappers, Daan Degrauwe, Roger Randriamampianina**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
RoSt, RoRa	Roel Stappers, Roger Randriamampianina (ERA6, RadPrO)	MET Norway	ERA6, RadPrO
ClFi, EtAr, AlMa, KaYe, REK, FlSu, FaVo	Claude Fischer, Etienne Arbogast, Alexandre Mary, Karim Yessad, Ryad El Khatib, Florian Suzat, Fabrice Voitus (2, 5, 2, 3.5, 7, 3, 1)	Météo-France	23.5
DaDe	Daan Degrauwe	RMI Belgium	1
CaGe	Carlos Geijog	AEMET Spain	1
JeBo, NiGu	Jelena Bojarova, Nils Gustafsson (1, see DA2.2)	SMHI Sweden	1

WP objectives

The general goal is to enable an object-oriented C++ layer for control of the IFS/ARPEGE/LAM data assimilation (and forecast model) applications. The computational code remains in FORTRAN, based on the IFS/Arpège/LAM shared codes, but has to be adapted (re-factored) towards an OO coding.
The ultimate target is be to be ready to switch any NWP system to OOPS binaries in a (reasonably not too long) delay of time after ECMWF did so for IFS. The present plan at EC is to switch OOPS to operations by mid-2019.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DA6.1	FORTRAN code re-factoring, within IFS/ARPEGE cycles, including ARPEGE and LAM phasing to re-factoring aspects. Find technical solutions to implement intended HIRLAM-ALADIN LAM data assimilation algorithmic components and developments within the OOPS framework. Develop and promote the use of block unit tests for HIRLAM-ALADIN LAM data assimilation components. Document the design of the LAM data assimilation code and testing framework under OOPS, and transfer knowledge on this to the ALADIN-HIRLAM community.	KaYe, AlMa, REK, ClFi, RoSt, EtAr, FlSu	t-codes
DA6.2	Participation in C++ layer(managed at ECMWF) and support to scientists (for getting hand-on the OOPS system)	EtAr, RoSt	t-codes, OOPS interface codes
DA6.3	Develop prototypes	EtAr, AlMa	non t-codes
DA6.4	Full-POS for OOPS(import (e)927 facility inside OOPS executables)	REK	t-codes
DA6.5	Specific ARPEGE/LAM issues for re-factoring (DDH, LBC)	AlMa, KaYe, FaVo	t-codes
DA6.6	Digital filter initialization in OOPS	DaDe	t-codes
DA6.7	OOPS-compliant design of the variational data assimilation: Set up/ test LAM OOPS 3DVAR, develop large scale error constraint, consider VarBC and VarQC, allow centred FGAT.	RoSt	t-codes
DA6.8	Enable LAM flow-dependent assimilation in OOPS: Design/implement extension of control vector space with additional cost terms and regularization constraints; study scale-dependent localisation and time dimension, treatment of non-linear components. The realisation of this task depends on the development of OOPS at ECMWF/MF.	RoSt, NiGu, JeBo	t-codes
DA6.9	Participation to technical coordination meetings (incl with EC), OOPS Board (CF only), workshops	ClFi, EtAr, KaYe, AlMa, RoSt, RoRa	minutes of meetings
DA6.10	Treatment of non-additive errors: further develop the integration of field alignment into variational data assimilation and OOPS.	RoSt, CaGe, RoRa	non t-codes

t-code deliverables

Task	Responsible	Cycle	Time
DA6.1	EC/MF coordination (coordinators)	CY45 through CY47	end 2019 ?
DA6.2	EA & RSt	?	?
DA6.4	REK	CY46 or CY47	end 2018
DA6.5	AM	CY46 or CY47	end 2018
DA6.6	?	?	?
DA6.7	RSt	CY46 or CY47	end 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA6.3	EtAr for MF prototypes	updated prototype codes (outside IFS cycles)	?

DA6.9	ClFi, RoSt, RoRa	minutes of meetings, technical notes, presentations for workshops	as relevant
DA6.10	RoSt, CaGe	CY46 or CY47	end 2018

ALADIN/HIRLAM/LACE WorkPackage description : DA7

WP number	Name of WP
DA7	Observation pre-processing and diagnostic tools
WP main editor	**Eoin Whelan, Alena Trojaková, Jean-Francois Mahfouf, Roger Randriamampianina**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
JaSa	Jana Sanchez	AEMET Spain	1
PaBe	Patrik Benacek	CHMI Czech	
BjAm, MaDa	Bjarne Amstrup, Mats Dahlbom (2, 2.5)	DMI Denmark	4.5
IsMo	Isabel Monteiro	IPMA Portugal	0.5
JaBa	Jan Barkmeijer	KNMI Netherlands	0.5
EoWh	Eoin Whelan	MET Eireann	3
RoRa	Roger Randriamampianina	MET Norway	CARRA
HeBe, FrGu, DoPu, DoRa	Hervé Benichou, Frank Guillaume, Dominique Puech, Dominique Raspaud (5, 1, 5, 2)	Météo-France	13
MaLi, MaRi	Magnus LIndskog, Martin Ridal (CARRA, PRECISE)	SMHI Sweden	CARRA, PRECISE

WP objectives

Objectives are:
- To contribute to the overhaul and streamlining of the observation pre-processing which is being realized in the COPE project. A main area of attention there will be the handling of radar observations in the COPE framework.
- For new observation types, such as e.g. MTG/IRS, all-sky radiances, develop software for the pre-processing and quality control of these data, and assess the need to apply variational bias correction.
- Where needed, extend observation usage monitoring and diagnostics tools with more diagnostics. Currently, we have the Obsmon for observation usage monitoring, the ObsTool for checking the effective observation error and thinning distance, the DFS (degrees of freedom for signals) to evaluate the impact of observations in the analysis system, and the MTEN (moist total energy norm) for evaluation of the sensitivity of the forecast model to the observations.
- Study the feasibility of implementation of the FSOI (forecast sensitivity to observation impact) in limited area model (LAM).
- Explore alternative for observation pre-processing. Recently, SAPP (scalable acquisition and pre-processing) under development at ECMWF was promoted for local implementation and application.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DA7.1	Participate in the ECMWF COPE-3 project: replace QC filters from the pre-processing software; implement local data formats (radar, Mode-S, BUFR, ASCII) and functionalities (HDF reader, Lambert projection, report destruction); development of common blacklisting software; evaluate functionality a new prototype pre-processing system.	EoWh (1), MaDa (2), BjAm	T-Codes and non-T-codes
DA7.2	Diagnostic tools: Continue the implementation and extension of diagnostics tools. 1) ObsTool to evaluate the effective observation error and thinning distance; 2) DFS to evaluate the impact of observations on the analyses; 3) MTEN to evaluate the impact of observations on the forecast model, 4) Feasibility study of FSOI in LAM.	JaSa (1), MaDa (0.5), MaLi, MaRi, RoRa, JaBa (0.5), PaBe, HeBe, DoPu, DoRa	non-T-codes report
DA7.3	Maintenance and development of ODB software, basic extraction tools from the raw observations to ODB (bator, b2o). Update Bator to handle new types of observations, like for example, All-Sky radiances or ADM Aeolus.	EoWh (1), FrGu	non-T-codes
DA7.4	Explore the the potential of SAPP for local observations pre-processing.	EoWh(1), IsMo (1)	non-T-codes

T-code deliverables

Task	Responsible	Type of deliverable	Time
DA7.1	EW	CY46T1	end 2018

Non-t-code deliverables

Task	Responsible	Cycle	Time
DA7.1	EoWh	CY46	end 2018
DA7.2	DoRa	Technical report	end 2019
DA7.2.1	PaBe	CI	end 2018
DA7.2.2	RoRe	CI	end 2018
DA7.2.3	RoRe	CI	end 2018
DA7.2.4	JaBa	CI	end 2018
DA7.3	EoWh	CY46	end 2018
DA7.4	IsMo, EoWh	Technical note	

ALADIN/HIRLAM/LACE WorkPackage description : DY1

WP number	Name of WP
DY1	Boundary conditions and nesting
WP main editor	**Sander Tijm**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MaTu	Martina Tudor (to be confirmed)	DHMZ Croatia	2
HeTr	Heido Trofimov?	ESTEA Estonia	2?
CoCl	Colm Clancy	MET Eireann	2
MaKu	Marco Kupiainen	SMHI Sweden	1?

WP objectives

All limited area models use Davies-Kållberg relaxation towards the host model in the lateral boundary coupling zone. Attempts to use a more elegant approach (strong constraint transparent boundary conditions) for operational purposes have been unsuccessful. Presently, the option to use a weak constraint implementation of the lateral (and upper) boundary conditions is being pursued. For the upper boundary conditions, spectral nudging and Davies relaxation to the host model can be employed. The latter method appears to improve the stability of the model in cases of very strong winds at or near the highest model level. Aspects deserving further study are the influence of domain size on the influence of the host model through the boundary conditions, the influence of the width of the relaxation zone, the choice of model top and upper boundary treatment and the vertical interpolation used in the boundary generation.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DY1.1	Continue investigating the replacement of upper boundary spectral nudging by a relaxation of either Davies or weak constraint type which suppresses the instabilities seen on the upper boundary by the non-hydrostatic model run at very high horizontal resolutions.	MaKu, ext	t-code?
DY1.2	Impose weak constraint boundary condition in the vertical discretization (using Vertical Finite Elements). Derive mathematical proof of stability.	MaKu, ext	Report/paper
DY1.3	Study the vertical interpolation used in the boundary file generation	Cocl	t-code?, configuration

t-code deliverables

Task	Responsible	Cycle	Time
DY1.1	tbd		Q4 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY1.2	MaKu	Report/Paper	Q3 2017?
DY1.3	CoCl	t-Code?, configuration	Q4 2018

ALADIN/HIRLAM/LACE WorkPackage description : DY2

WP number	Name of WP
DY2	Time-stepping algorithm
WP main editor	**Petra Smolíková**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PeSm	Petra Smolíková	CHMI Czech	1
CoCl	Colm Clancy	MET Eireann	2
JoVi	Jozef Vivoda	SHMU Slovakia	4

WP objectives

To maintain and develop time-stepping procedure in the non-hydrostatic dynamical core of the ALADIN-HIRLAM System based on the given constraints. The basic algorithmic choices remain here unchanged: semi-implicit time scheme and spectral horizontal representation of prognostic variables. Tests in higher horizontal resolutions than those used currently in operational applications (being close or less than 1km) reveal that in most of the cases the SETTLS time scheme is enough to deliver stable solution while there appear some cases when at least one iteration of the iterative centred implicit scheme is needed. When going to higher resolutions it may happen that even one iteration is not enough. We want to determine a condition which will evaluate the stability of the integration and in case there is an indication of poor stability the iteration will be started. Ones such condition defined, the time scheme would become more efficient and the computer time will be invested only when needed.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DY2.1	Dynamic definition of the iterative time schemes: the corrector step "on demand" according to a diagnostic of scheme stability or according to a prescribed pattern (i.e. every Nth step in a given set of vertical levels) for non-linear residual calculation.	JoVi	t-code

t-code deliverables

Task	Responsible	Cycle	Time
DY2.1	JoVi	CY45T1	end of 2017

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY2.1	JoVi	Report, ideal cases study	end of 2018

ALADIN/HIRLAM/LACE WorkPackage description : DY3

WP number	Name of WP
DY3	Vertical discretization
WP main editor	**Petra Smolíková**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
JuSi	Juan Simarro	AEMET Spain	
PeSm	Petra Smolíková	CHMI Czech	2
JoVi	Jozef Vivoda	SHMU Slovakia	1

WP objectives

To maintain, develop and possibly externalize the vertical discretization of both, hydrostatic and non-hydrostatic dynamical core of the ALADIN-HIRLAM System based on the given constraints. To finalize the implementation of finite element discretization in the vertical direction of the non-hydrostatic kernel of the ALADIN-HIRLAM System. To address remaining problems, phase the existing modification to the official cycle and document the development in a scientific paper. To externalize the whole vertical discretization from other model parts.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DY3.1	Finalization of the VFE developments and phasing of the existing modification	JoVi, PeSm	t-code
DY3.2	An overview of the results on VFE in a scientific paper	JoVi, PeSm, JuSi	non-t-code
DY 3.3	The externalization of the vertical discretization.		

t-code deliverables

Task	Responsible	Cycle	Time
DY3.1	JoVi	CY45T1	end of 2017

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY3.2	PeSm	Scientific paper	end of 2018
DY3.3		Feasibility study	end of 2018

ALADIN/HIRLAM/LACE WorkPackage description : DY4

WP number	Name of WP
DY4	Semi-Lagrangian advection
WP main editor	**Petra Smolíková**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PeSm	Petra Smolíková	CHMI Czech	1
AlCr	Alexandra Craciun	Meteo Romania	2

WP objectives

To test the semi-Lagrangian advection algorithm in high horizontal resolutions and draw conclusions on its design. As we increase the model horizontal resolution, the local divergence can increase significantly and the Lipschwitz criteria may be broken locally. Then the trajectory search may become divergent. Then the increase in the number of iterations in the process to search for a SL trajectory may lead to even less accurate solutions. Similar problems have been identified at ECMWF in IFS and fixed by local change of the computation of the half level wind. These considerations should be confirmed in more detailed study.
Further, to study mass conservation which is important in long integrations (for regional climate applications) and for atmospheric chemistry. Conserving SL schemes exist, but these are prohibitively expensive; therefore, adaptations of the SL method are sought which conserve mass better but do not involve a large increase in computational cost. The elimination of aliasing on vorticity over orography, and of the quasi-monotonicity in the high-order bi-dimensional interpolation used in the solution of the continuity equation, have led to better mass conservation for dry air. As a next step, it will be considered to enhance mass conservation for individual atmospheric components in the SL treatment of the mixing ratio equations. Also, it will be explored whether with the introduction of the COntinuous Mapping about Departure points (COMAD) option for interpolation, the quasi-monotonous scheme can be replaced altogether.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DY4.1	Check the convergence of the iterative algorithm for trajectory search in kilometric resolutions, draw conclusions.	AlCr	non-t-code
DY4.2	Investigate the compatibility of COMAD and Quasi-Monotonous (QM) interpolation within SL.	tbd (Sander)	Configuration
DY4.3	Eliminate the quasi-monotonicity in the interpolations used for the SL treatment of the continuity equation for atmospheric components other than dry air (water, ozone, chemical constituents). Assess whether the QM scheme could be replaced altogether when using the COMAD option.	Tbd (Sander)	t-code
DY4.4	Compare mass conservation properties for the different available options for computation of trajectory and interpolation at departure point within the global model.	Tbd (Sander)	Configuration

t-code deliverables

Task	Responsible	Cycle	Time
DY4.3	tbd		Q4 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY4.1	AlCr	Report	end of 2017
DY4.2	tbd	Namelist	
DY4.4	tbd	Namelist	

ALADIN/HIRLAM/LACE WorkPackage description : PH1

WP number	Name of WP
PH1	Developments of AROME-France (and ARPEGE) physics
WP main editor	**Claude Fischer and Yves Bouteloup**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
HaDh	Hajer Dhouioui	INM Tunisia	4
KEL	Kamal El Karouni	Maroc Meteo	1
YvBo, ErBa, YaSe, RaHo, PaMa, JMP, CeLo, InEt, OlJa, LaTh	Yves Bouteloup, Eric Bazile, Yann Seity, Rachel Honnert, Pascal Marquet, Jean-Marcel Piriou, Cécile Loo, Ingrid Etchevers, Olivier Jaron, Laetitia Thouron : CNRM/GMAP (7, 6, 4.5, 3.5, 4.5, 5, 4, 5, 10, 5)	Météo-France	54.5
ChLa, SeRi, BeVi, QuLi	Christine Lac, Sébastien Riette, Benoit Vié, Quentin Libois : CNRM/GMME (1, 5.5, 7.5, 5.5)	Météo-France	19.5
ViHo	Viktoria Homonnai	OMSZ Hungary	3
MoMo, MSEB, AbAm	Mohamed Mokhtari, Mohamed Siraj Eddine Bouzhaia, Abdenour Ambar (1, 1, 1)	ONM Algeria	3
ChWi, JoKe	Christoph Wittmann, Josef Kemetmüller (1, 2)	ZAMG Austria	3

WP objectives

Improve the physics parameterizations and diagnostics of the MF NWP configurations, which encompass AROME-France, the other AROME configurations (Overseas, Assistance etc.) and ARPEGE. This activity includes addressing model weaknesses seen in the operational MF suites, developing R&D for improving or extending existing parameterizations as well as developing new parameterizations. Additional efforts relate to developing new model research diagnostics, new model output products (using mostly output from the physics), addressing the use of physics as a component of multi-physics in the EPS, linearized physics for global 4D-VAR.
Note: work on sub-km versions of AROME is reported in the corresponding work package sheet (very high resolution)

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH1.1	AROME core physics efforts: assess performance of dynamical adaptation versus DA versions, seen from the forecast model point of view, improve wind gust modelling, further improve ICE3/ICE4 especially with respect to forecast of hail, assess the dependence of AROME microphysics to model time step, tests of LIMA with a view on numerical cost versus meteorological performance,	YaSe, ErBa, RaHo, SeRi, HaDh, KEL, ViHo	doc, t-code
PH1.2	LIMA microphysics scheme development	BeVi, ChLa	doc (Méso-NH results at first place)
PH1.3	Reassess some basics about thermodynamics and turbulence in our models: Lewis number # 1, review stability functions for PBL, consistent moist energy definition and energy transformation cycle	PaMa	doc, papers, t-code
PH1.4	Assess a first (early) version of dust aerosol forecast facility in AROME	LaTh, FrBs, YaSe, YvBo, AbAm, MoMo	doc
PH1.5	Processes and parameterization codes for radiation: get an overall knowledge of existing radiation codes, their underlying processes, the input data (optical properties, input climatologies, etc.). Assess their performances within MF's NWP systems. Note: this work includes the new code ECRAD from ECMWF.	QuLi, YvBo, MSEB	doc
PH1.6	Model output diagnostics: evaluation of new visibility diagnostic, test 4-point interpolation in Full-POS, further improve DDH, application-oriented model outputs (for aviation end-users)	YvBo, InEt, OlJa, JMP, HaDh, ChWi, JoKe	notes, t-code
PH1.7	ARPEGE-specific aspects: reassess the scientific choices and the code of the convection scheme PCMT (collaboration with climate group), intercomparison effort of parameterization schemes between ARPEGE and IFS, linearized physics (microphysics aspects) in 4D-VAR, adapt physics tunings to the new target resolution of ARPEGE in 2018 (5km over Western Europe),	JMP, YvBo, PaMa, ErBa, CeLo	t-code, namelists

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : PH2

WP number	Name of WP
PH2	Developments of HARMONIE-AROME physics
WP main editor	**Sander Tijm**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
JaCa, GeMo, DaMa, SaVi	Javier Calvo, Gema Morales, Daniel Martin, Samuel Viana (2, 6, 4, 1)	AEMET Spain	13
KPN	Kristian Pagh Nielsen	DMI Denmark	2
LaRo	Laura Rontu	FMI Finland	3
JPP	Joni-Pekka Pietikainen	FMI Finland	Ext
WdR, PeBa, SaTj, HydV, SvdV, PiSi, JFMe, EvM	Wim de Rooij (4), Sander Tijm (1) , Hylke de Vries (2), Sibbo vd Veen (1), Peter Baas (ext), Pier Siebesma (ext), Jan Fokke Meirink (ext)	KNMI Netherlands	8
EmGl	Emily Gleeson	MET Eireann	3
BJE, TeVa	Bjorg Jenny Engdahl, Teresa Valkonen	Met Norway	ext
AbBa	Abdelhak Bahlouli	ONM Algeria	1
LiBe,KII	Lisa Bengtsson	SMHI Sweden	Advisor
KII	Karl-Ivar Ivarsson	SMHI Sweden	2.5
DaBe	Danijel Belusic	SMHI Sweden	Ext
HaSo	Harald Sodemann	University of Bergen	Ext

WP objectives

Verify and where possible improve the general representation of clouds and microphysics (tasks PH2.1 - PH2.5). Weaknesses like the too weakly precipitating cold outbreak convection and the impact of surface data assimilation are studied. Further, the impact of more realistic descriptions for aerosols/ condensation nuclei on the development of clouds and precipitation are studied and where possible, improved. The behaviour of the LIMA scheme will be assessed and compared to the present ICE3 scheme.
Work to improve the realism of the radiation schemes and the interaction between radiation and clouds and/or aerosol (tasks PH2.6 – PH2.8). Currently very simple assumptions are made for aerosols that have a significant impact on the clouds and radiation. The aim is to achieve a more realistic description of aerosol and thereby achieve a more accurate model representation of clouds and radiation). Also, the impact of the intermittent calling of the full radiation scheme and possible improvements are investigated.
Study the model weaknesses under stable boundary layer conditions and test potential improvements (tasks PH2.9 – PH2.11). Especially the generally too low nighttime temperatures and the failure to represent observed very low temperature minima in very cold conditions will be targeted.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH2.1	1D Cloud studies: Evaluation of physical parameterizations in “common MUSC”, see also PH4.	WdR	publication
PH2.2	Convection: Study the impact of physics and dynamics choices on the initiation and strength of deep convection	JaCa, SaTj, KII, WdR	configuration
PH2.3	Explore the use of cellular automata and addition of stochasticity	SaTj	t-code, configuration
PH2.4	3D Cloud studies and CRIME-project: In-depth comparison of Harmonie-Arome 3D cloud fields with SAF satellite cloud products and Cloudnet and methods such as SAL and FSS. Within CRIME also the cloud representation will be studies with LES.	GeMo, WdR,	t-code, Report
PH2.5	Microphysics: Improve statistical representation of sub-grid microphysics, implement in ICE3 microphysics a 3D daily updated Nc, test if cloud cover calculation and ice nucleus concentration parametrization can be improved with PBL height information. Explore the behaviour of LIMA. PhD work on the implementation of the Thompson microphysics scheme.	KII, BJE, DaMa	t-code, proposal for namelist changes
PH2.6	Ensure consistency between the current cloud microphysics and radiation schemes. Import effective size (radius) of cloud ice, cloud liquid, graupel, snow and rain particles from microphysics to the radiation schemes. Externalise effective radius calculations from inside IFS, ACRANEB2 and HLRADIA; develop, recode, test within MUSC cycle cy43 (45)	KII, EmGl	t-code, namelist
PH2.7	Radiation: Continue the comparison of the IFS, hlradia and Acraneb-2 short-wave and long-wave radiation schemes, consider as multi-physics options in HarmonEPS, work towards a unified radiation scheme in cooperation with ECMWF	LaRo, EmGl, KPN,	t-code, namelist
PH2.8	Aerosol: Prepare and test introduction of near-real-time aerosol for calculating the direct radiative effect of aerosols and cloud-aerosol interactions. Prepare the interfacing of an external library with aerosol and chemical parameterizations (Related external funding proposal: Joni-Pekka Pietikäinen)	LaRo, KPN, JPP, AbAm	t-code, namelist

PH2.9	SBL studies: Assess known weaknesses in the Stable Boundary Layer (SBL) regime, evaluation of HARATU vs CBR in the SBL, study the influence of vertical resolution on decoupling in SBL, study cloud microphysics and radiation interactions. Proposal MetNo on Arctic stable boundary layer	TVa, WdR, PeBa, MaHo, LaRo, EmGl, RaGr	t-code, namelist
PH2.10	Surface influence on SBL: Study the influence of snow, ice, vegetation and impact of the multiple energy balance scheme on the model boundary layer under stable conditions;investigate the use of higher resolution surface information (e.g. variance within grid cell)coupled to the atmospheric model	AbB	t-code, namelist
PH2.11	Study the relative role and interaction of parametrizations and data assimilation on the SBL.		

t-code deliverables

Task	Responsible	Cycle	Time
PH2.3	SaTj		2018?
PH2.4	WdR		Q4 2018
PH2.5	KII		
PH2.6	KPN		
PH2.7	LaRo		
PH2.8	LaRo/JPP		
PH2.9	TeVa, WdR, MaHo		
PH2.10			

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH2.1	WdR	Publication	
PH2.2	JaCa	Proposed namelist changes	
PH2.4	GeMo, WdR	Report	Q4 2018 (WdR)
PH2.5	KII	Namelist	
PH2.6	KPN	Namelist	
PH2.7	LaRo	Namelist	
PH2.8	LaRo/JPP	Namelist	
PH2.9	TeVa, WdR, MaHo	Namelist	
PH2.10		Namelist	

ALADIN/HIRLAM/LACE WorkPackage description : PH3

WP number	Name of WP
PH3	Developments of ALARO physics
WP main editor	**Neva Pristov**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PeSm, NePr, JuCe	Peter Smerkol, Neva Pristov, Jure Cedilnik (3, 2, 1)	ARSO Slovenia	6
RaBr, JaMa	Radmila Brožkova, Jan Mašek (9, 5)	CHMI Czech	14
MaHr, SuPen, MaTu	Mario Hrastinski, Suzana Penezić, Martina Tudor (3, 1, 2)	DHMZ Croatia	6
BoBo	Bogdan Bochenek	IMGW Poland	1
CaKa	Canbert Karadavut	MGM Turkey	2
LuGe, DaDe	Luc Gerard, Daan Degrauwe (10, 2)	RMI Belgium	12
MaDi	Martin Dian	SHMU Slovakia	3
ChWi	Christoph Wittmann	ZAMG Austria	1

WP objectives

One of the ALADIN CMC is ALARO which is used in many operational applications, LAM EPS systems and climatological simulations. The aim is to improve or extend the existing parameterizations and continue developing new one (CSD). Next well tuned version could have non-saturated downdraught and few additional novelties (prognostic graupel, revision of mixing length and TOMs in TOUCANS). Validation of ALARO coupled with SURFEX will take place.Additionally, some effort will be put to new model output products.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH3.1	Radiation scheme – minor improvements	JaMa	doc, t-code
PH3.2.1	TOUCANS scheme – code re-organization, cleaning, debugging	PeSe, RaBr	doc, t-code
PH3.2.2	TOUCANS scheme – mixing length computation	MaHr, RaBr, JaMa	doc, t-code
PH3.2.3	TOUCANS scheme - shallow convection	RaBr, JaMa	doc, t-code
PH3.3	Cloud scheme	JaMa, RaBr, LuGe	doc, t-code
PH3.4	Non-saturated downdraught	LuGe	doc, t-code
PH3.5	Complementary Subgrid Drafts (CSD)	LuGe	doc, t-code
PH3.6	Microphysics – prognostic graupl	BoBo, RaBr	doc, t-code
PH3.7	Coupling ALARO-1 and SURFEX	SuPem, MaTu, JuCe, NePr, CaKa, DaDe, MaDi, JaMa	doc, t-code
PH3.8	ALARO-1 validation and maintenance	JaMa, RaBr	t-code
PH3.9	Model output diagnostics, products: lightening, visibility	ChWi, JuCe, NePr	doc, t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : PH4

WP number	Name of WP
PH4	Common 1D MUSC framework for parametrization validation
WP main editor	**Sander Tijm, Wim de Rooij and Eric Bazile**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
WdR	Wim de Rooij	KNMI Netherlands	1
BJE	Bjorg Jenny Engdahl	Met Norway	external
ErBa, YvBo	Eric Bazile, Yves Bouteloup (1, 1)	Météo-France	2
BaSz	Balazs Szintai	OMSZ Hungary	1
DaDe	Daan Degrauwe	RMI Belgium	2

WP objectives

Maintain and regularly upgrade a “common MUSC” 1D testing environment for Arome-France and Harmonie-Arome, for the evaluation of physics parametrizations against Cloudnet and LES data and idealized experiments.
Add relevant 1D test cases to the “common MUSC” system, which presently contains e.g. GABLS-1, GABLS4, ARM-Cu, ASTEX and a Cabauw fog case. Desired new cases include e.g. a case with light precipitation (RICO), dry convection, and an idealized case for mixed-phase clouds.
The actual evaluation of Arome-France and Harmonie-Arome physics schemes in the 1D common MUSC against the available test cases is described in WP PH1 and PH2 (tasks PH2.1 and PH2.5).

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH4.1	Maintain and upgrade “common MUSC” system	DaDe	
PH4.2	Create and add (idealized) test cases		

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH4.2	WdR, ErBa, BJE	New (idealized) test cases	

ALADIN/HIRLAM/LACE WorkPackage description : SU1

WP number	Name of WP
SU1	Assimilation algorithms for surface assimilation
WP main editor	**Rafiq Hamdi**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
SuPa	Suzana Panežić	DHMZ Croatia	1
EkKo	Ekaterina Kourzeneva (1 + 2 MetCoOp*)	FMI Finland	3
SiTh	Sigurður Þorsteinsson	IMO Iceland	1.5
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui (2, 2)	Maroc Meteo	4
MaHo, TrAs	Mariken Homleid, Trygve Aspelien (1.5 + MetCoOp*, 2 + MetCoOp*)	MET Norway	3.5
CaBi, ErBa	Camille Birman, Eric Bazile (4.5, 1.5)	Météo-France	6
RaHa	Rafiq Hamdi	RMI Belgium	0.5
ViTa	Viktor Tarjani	SHMU Slovakia	6
KIIv, PaSa, JeBo, MaLi, ToLa	Karl-Ivar Ivarsson, Patrick Samuelsson, Jelena Bojarova, Magnus Lindskog, Tomas Landelius (1 + MetCoOp*, RSLand* + CARRA*, 1 + 2 CARRA* & PRECISE*, 2 IMPREX*, 1 RSLand*)	SMHI Sweden	7

WP objectives

Introduce and assess more advanced data assimilation algorithms in SODA framework
Within the ALADIN/LACE/SURFEX community, new algorithms for the various surface components will be developed and introduced, starting with soil and snow. These algorithms will be based principally on various flavours of the Kalman Filter (Extended Kalman Filter (EKF), Short Time Augmented Extended Kalman Filter (STAEKF), Ensemble Kalman Filter (EnKF), ...). To get familiar with them, assimilation experiments will start using SYNOP data. Then new satellite (retrieval) products will be considered, to be followed by satellite radiances and the development of observation operators.
The Kalman Filters implementations in SODA should be compatible with the various choices of surface physics present in SURFEX (see WP SU3): the force-restore method or the diffusion soil scheme, the different snow schemes and the Multi Energy Budget explicit canopy vegetation scheme, and combinations thereof.

A number of adaptations of the horizontal spatialization tool CANARI (OI scheme) will also be considered.

Information on precipitation and downward radiation fluxes provided by surface networks and satellite remote sensing will be used in the algorithms in order to get improved surface analyses.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU1.1	Develop/assess EKF for soil, snow and vegetation using SYNOP data in combination with the force-restore, diffusion soil and the Explicit Snow (ES) scheme in SURFEXv8		see subtasks
SU1.1.1	Evaluate EKF for diffusion soil scheme as implemented in SURFEX/SODA and suggest eventual further modifications. Test should include options with non-evolving (SEKF) and evolving B-matrix and recommendation which to utilize. Take into account the outcome from similar works already done at Meteo-France.	EkKo, MaLi, JeBo, PaSa, SiTh	report
SU1.1.2	Implement/develop suggested modifications for DIF in SU1.1.1 and test the modified system.	EkKo, MaLi, JeBo, PaSa, ToLa, KIIv, MaHo, TrAs, SiTh	t-code, report
SU1.1.3	Develop and test OI/EKF for Explicit snow scheme. Coordinate with SU1.1.1 regarding choice of method(s).	TrAs, MaHo, PaSa, KIIv, ToLa, SiTh	t-code, report
SU1.1.4	Continue to test and develop STAEKF for LAI updates. Implement STAEKF for LAI-Albedo-RSmin within SODA/SURFEX-v8	JeBo	t-code, report
SU1.1.5	Combine the development in SU1.1.2-3 and set up a pre-operational system based on EKF for soil, snow and vegetation.	EkKo??, MaLi, JeBo, PaSa, ToLa, KIIv, MaHo, TrAs	report
SU1.1.6	Validation of EKF surface assimilation with SYNOP observations using force-restore method	ViTa	report
SU1.2	Modify CANARI/SURFEX to be able to access SURFEX variables from CANARI. E.g. utilize tile/patch variables in SURFEX as first guess in CANARI. Activate the MESCAN part of CANARI, and investigate sensitivity of anisotropic horizontal/vertical structure functions.	PaSa, EkKo, TrAs, MaHo, ErBa, SuPa	t-code, configuration
SU1.3	Further develop snow analysis and assimilation of snow extent in CANARI/MESCAN/SODA. Developments on snow analysis in CANARI for AROME-France	EkKo CaBi	t-code report
SU1.4	Develop/assess EKF for sea ice, using satellite products in combination with the SICE scheme.	BiCh, YuBa, EkKo	t-code, code
SU1.5	Investigating the use of Land-SAF product when building the Jacobian matrix for EKF/STAEKF	RaHa	t-code, configuration report

SU1.6	Surface analysis strategy for AROME-MAROC	ZaSa, FaHd	

t-code deliverables

Task	Responsible	Cycle	Time
SU1.1.2	EkKo??	SURFEX code contributions	Mid 2018
SU1.1.3	MaHo	SURFEX code contributions	Mid 2018
SU1.1.4	JeBo, ArDj	SURFEX code contributions	Mid 2018
SU1.2	PaSa	SURFEX code contributions, cy46+	End 2018
SU1.3	EkKo	SURFEX code contributions, cy46+	End 2018
SU1.4	YuBa	SURFEX code contributions, cy46+	Summer 2019
SU1.5	ArDj	SURFEX code contributions	End 2019

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU1.1.1	MaLi	Evaluation report	Spring 2018
SU1.1.2	EkKo	Evaluation report	Mid 2018
SU1.1.3	PaSa	Evaluation report	Spring 2019
SU1.1.4	ArDj	Evaluation report	End 2018
SU1.1.5	PaSa	Evaluation report	End 2018
SU1.1.6	ViTa	Evaluation report	End 2018
SU1.2	MaHo	Namelist changes	Summer 2018
SU1.3	CaBi	Evaluation report	End 2018
SU1.4	YuBa	HARMONIE script system	Summer 2019
SU1.5	ArDj	Evaluation report	End 2019

ALADIN/HIRLAM/LACE WorkPackage description : SU2

WP number	Name of WP
SU2	Use of observations in surface assimilation
WP main editor	**Stefan Schneider**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
EkKo	Ekaterina Kourzeneva	FMI Finland	2
BiCh	Bin Cheng	FMI Finland	INTAROS*, TWASE*
JoDV	John de Vries	KNMI Netherlands	3
MaHo	Mariken Homleid	MET Norway	MetCoOp*
YuBa	Yurii Batrak	MET Norway	External project not confirmed yet (2.7*)
CaBi	Camille Birman	Météo-France	3
RaHa	Rafiq Hamdi	RMI Belgium	0.5
MaLi	Magnus Lindskog	SMHI Sweden	2 IMPREX*
ToLa	Tomas Landelius	SMHI Sweden	2 RSLand*
StSc	Stefan Schneider	ZAMG Austria	3

WP objectives

New observations will be introduced from satellite products/radiances representing surface temperature (land/sea-ice/lake), surface soil moisture, snow cover, snow water equivalent, snow albedo (land, sea-ice), sea-ice cover, and vegetation properties. First, retrieved products (e.g. top soil moisture) will be applied or calculated. As a next step, it will be attempted to utilize radiances more directly via suitable observation operators. Priority should be given to operationally available satellite products (temporary research products should in principle be avoided). Unconventional surface observations that will be considered include sea-ice mass balance (SIMBA) buoys.
This WP also includes the topic of data pre-processing. This involves e.g. if (and if so, how) satellite observation data shall be spatialized; how data can enter ODB, as a preparation for having the data available for assimilation in SU1

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU2.1	Examine available satellite snow-extent (and Snow-Water Equivalent products?) products and make them available in ODB. E.g. H-SAF.	EkKo, MaHo	report, code
SU2.2	Examine available satellite soil moisture products for use in surface data assimilation. The description of the sub-taks contains the following information: [soil moisture product] - [assimilation method] - [SURFEX version].		
SU2.2.1	[ASCAT, AMSR-2, ...] - [EnKF] - [8.0*]	JoDV	report, code
SU2.2.2	[ASCAT, AMSR-2, SAR-C (Sentinel-1), ...] - [tbd] - [tbd]	MaLi, ToLa	report, code
SU2.2.3	[SCATSAR-SWI (combined Sentinel-1 + ASCAT product)] - [sEKF] - [8.0]	StSc	publication
SU2.3	Examine available satellite sea-ice extent products and make them available in ODB. E.g. OSI SAF	YuBa, BiCh	report, code
SU2.4	Explore the possibility to use SIMBA buoys for assimilation of sea-ice conditions.	BiCh, YuBa	report
SU2.5	Examine available LSA-SAF products for use in surface data assimilation. The description of the sub-taks contains the following information: [satellite product] - [assimilation method] - [SURFEX version].		
SU2.5.1	[Land-SAF radiation] - [tbd] - [tbd]	RaHa	report
SU2.5.2	[surface temperature products (MSG, MODIS, Sentinel-3)] - [(s)EKF] -[8.1]	StSc	report
SU2.5.3	[radiation, albedo, LAI or surface temperature (tbd)] - [tbd] - [tbd]	CaBi	report

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU2.1	EkKo	report, script changes	Mid 2018
SU2.2.1	JoDV	report, script changes	tbd
SU2.2.2	ToLa	report, script changes	Mid 2018
SU2.2.3	StSc	publication	Mid 2018
SU2.3	YuBa	report, script changes	End of 2018 or later
SU2.4	BiCh	report	Mid 2018
SU2.5.1	RaHa	tbd	tbd
SU2.5.2	StSc	report	Mid 2019
SU2.5.3	CaBi	report	End 2019

ALADIN/HIRLAM/LACE WorkPackage description : SU3

WP number	Name of WP
SU3	SURFEX: validation of existing options for NWP
WP main editor	**Patrick Samuelsson and Samuel Viana**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
SaVi	Samuel Viana	AEMET Spain	6
SuPa	Suzana Panežić	DHMZ Croatia	3
EkKo	Ekaterina Kourzeneva	FMI Finland	3
BoPa, NiNa	Bolli Palmason, Nikolai Nawri	IMO Iceland	0, 1? + Icelandic external projects with snow focus*
JodVr	John de Vries	KNMI Netherlands	3
MaHo, TrAs	Mariken Homleid, Trygve Aspelien (1, 1 + MetCoOp*)	MET Norway	2
EmGl	Emily Gleeson (maybe 4 (out of 10))	MET Eireann	4
SiTa	Simona Tascu	Meteo Romania	1
PaLM, AaBo	Patrick Le Moigne, Aaron Boone : CNRM/GMME (4, 3)	Météo-France	7
YaSe, GhFa	Yann Seity, Ghislain Faure : CNRM/GMAP (1, 2)	Météo-France	3
BaSz	Balázs Szintai	OMSZ Hungary	2
OuDo	Oussama Douba	ONM Algeria	1
RaHa	Rafiq Hamdi	RMI Belgium	3
PaSa	Patrick Samuelsson	SMHI Sweden	RSLand*
StSc	Stefan Schneider	ZAMG Austria	2

WP objectives

Explore and validate available SURFEX physics components:
More advanced assimilation methods (SU1) and more types of observations (SU2) will also make it possible to utilize more physically based surface components for the nature tile (ISBA) which are not really accessible in combination with OI. These components, as available from SURFEXv8/cy43, include e.g. diffusion soil scheme (DIF), multi-layer explicit snow scheme (ES) and Multi-Energy Budget (MEB). Similar versions of these components are operational in the latest release of the HIRLAM model and have provided increased skill over certain areas. For NWP we have started to explore some of the new physicis componenets in ISBA of SURFEXv8, mainly ES and DIF. The DIF scheme also offers a number of hydrological options. Assessing the potential of the new options should be done in tight connection to the corresponding assimilation methods (SU1). When one or more of these options are activated and tested, routine validation against in-situ data should be complemented with e.g. non- conventional near-surface observations, flux tower data, and satellite products. All parameterizations include parameters with some level of uncertainty. Thus, given a new release of a ALADIN-HIRLAM cycle there are a number of parameters in SURFEX (currently with focus on ISBA) which, if they are tuned, may give yet a bit better performance of a certain setup (domain). Methods for such optimization are being developed.

The nature and sea tiles represent the dominating fraction of the surface which means that they are the most important tiles to model well from an atmospheric point of view. On the other hand, the inland water and town tiles are relatively small and therefore it is not as crucial to apply surface data assimilation for these tiles. For example, the plan is to utilize the lake model FLake without data assimilation. The situation is simiar for towns where the Town-Energy Balance (TEB) model is running.

The 1D ocean mixing layer model CMO has been tested and implemented in some AROME configurations at Météo-France (Overseas). The intention is to further improve this coupling for tropical cyclone prediction.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU3.1	Test and validate the behaviour of individual components, as well as the full combination, of DIF, ES, MEB in cy43/SURFEXv8.1. Utilize a combination of offline SURFEX, MUSC, and the full 3D model depending on the type of study. Also, utilize climate-mode simulations (without data assimilation) to identify and reduce biases.	SaVi, PaSa, MaHo, EkKo, NiNa, BoPa, EmGl, JodVr, TrAs, PaLM, AaBo, YaSe, SuPa	see subtasks
SU3.1.1	In climate mode, over different domains, examine biases in cy43h when the full combination of DIF, ES, MEB are activated in combination with recommended namelist settings.	SaVi, PaSa, MaHo, EkKo, NiNa, EmGl, JodVr, TrAs, YaSe	report
SU3.1.2	By namelist modifications, parameter tuning and/or code modifications try to reduce any biases identified in SU3.1.1	SaVi, PaSa, MaHo, EkKo, NiNa, BoPa, EmGl, JodVr, TrAs, PaLM, AaBo	configuration, t-code
SU3.1.3	Based on the outcome of SU3.1.2, repeat the simulations for different domains as done in SU3.1.1 and evaluate the performance. This version of HARMONIE-AROME will be used for coupling to surface data assimilation in SU1.	SaVi, PaSa, MaHo, EkKo, NiNa, BoPa, EmGl, JodVr, TrAs	report
SU3.2	Develop methods for parameter optimization in SURFEX (ISBA) and apply the method on an operational cycle to reach better performance.	JodVr	t-code, code, configuration
SU3.3	Examine the potential use of, until now, non-utilized options in TEB.	EkKo	report, configuration
SU3.4	Test DIF in the framework of (S)EKF assimilation of SWI (Soil Water Index) in SURFEX 8.0/8.1, combined with AROME CY40T1. Validation with SYNOP stations.	StSc	report

SU3.5	Further improve AROME/CMO coupling for tropical cyclone prediction	GhFa	report
SU3.6	Test of FLake in the Hungarian AROME-SURFEX system	BaSz	report

t-code deliverables

Task	Responsible	Cycle	Time
SU3.1.2	SaVi, PaSa	SURFEX code contributions, namelist changes	Autumn 2018
SU3.2	JodVr	SURFEX code contributions	Summer 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU3.1.1	SaVi	report	Spring 2018
SU3.1.3	PaSa	report	Spring 2019
SU3.2	JodVr	script changes, namelist changes	Summer 2018
SU3.3	EkKo	report, namelist changes	End of 2018
SU3.4	StSc	report	Mid 2018
SU3.5	GhFa	report	End of 2018

ALADIN/HIRLAM/LACE WorkPackage description : SU4

WP number	Name of WP
SU4	SURFEX: development of model components
WP main editor	**Patrick Samuelsson**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
KPNi, RuMo	Kristian Pagh Nielsen, Ruth Mottram (0.5?, External projects)	DMI Denmark	0.5
BiCh, LaRo, EkKo	Bin Cheng, Laura Rontu, Ekaterina Kourzeneva (0.5?, 3, 2 MetCoOp*)	FMI Finland	5.5
BoPa	Bolli Palmason (to be confirmed)	IMO Iceland	1
YuBa	Yurii Batrak	MET Norway	PhD work*
AaBo	Aaron Boone : CNRM/GMME	Météo-France	3
YaSe, AlMa	Yann Seity, Alexandre Mary : CNRM/GMAP (1, 3)	Météo-France	4
JuBe	Julie Berkmans	RMI Belgium	3
PaSa	Patrick Samuelsson	SMHI Sweden	0.75

WP objectives

Further develop SURFEX surface model components:
In SURFEX there are under development, or still missing, processes which the NWP team can help to develop further. These include e.g. an increase in sophistication for the Simple Ice scheme (SICE), a glacier model, the lake model FLake, radiation/orography aspects, the introduction of an orographic roughness parameterization, the Multi-Energy Budget (MEB) scheme, adiitional parameterization of fractional snow and improvement of winter aspects in the urban model TEB. Any new development should be contributed via the SURFEX repository to ensure that contributions become part of new SURFEX releases and that they enter new NWP cycles in a consistent way.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU4.1	Develop a physically based glacier model for SURFEX based on the Explicit Snow Scheme. Includes glacier albedo aspects.	BoPa, KPNi, RuMo	t-code
SU4.2	Further development of SICE.	YuBa, BiCh, EkKo	t-code
SU4.3	Evaluate the orographic/radiation implementation in Cy43 and apply further modifications/ developments.	LaRo, YaSe, AlMa	t-code
SU4.4	Evaluate and further modify/develop the orographic roughness parameterization.	LaRo	t-code
SU4.5	Merge FLake modifications in cy40h into the SURFEX repository as contribution to SURFEX general development.	EkKo	t-code
SU4.6	Further development of MEB which can include separate soil column under snow/non-snow, snow albedo in forest, effect of intercepted snow on albedo.	PaSa, AaBo	t-code

t-code deliverables

Task	Responsible	Cycle	Time
SU4.1	EmGl	SURFEX code contributions	Summer 2018
SU4.2	YuBa	SURFEX code contributions	End of 2018
SU4.3	LaRo	SURFEX code contributions	End of 2018
SU4.4	LaRo	SURFEX code contributions	End of 2018
SU4.5	EkKo	SURFEX code contributions	End of 2018
SU4.6	PaSa	SURFEX code contributions	End of 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : SU5

WP number	Name of WP
SU5	Assess/improve quality of surface characterization
WP main editor	**Ekaterina Kourzeneva**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
SaVi	Samuel Viana	AEMET Spain	1
SuPa	Suzana Panežić	DHMZ Croatia	1
EkKo	Ekaterina Kourzeneva	FMI Finland	2
BoPa, SiTh	Bolli Palmason, Sigurður Þorsteinsson (1, 1)	IMO Iceland	2
JodVr	John de Vries	KNMI Netherlands	1
MaHo	Mariken Homleid	MET Norway	MetCoOp*
PaSa	Patrick Samuelsson	SMHI Sweden	CARRA*
KPNi	Kristian Pagh Nielsen	DMI Denmark	1.5

WP objectives

Assess and improve quality of surface characterization:
The surface physiography data currently used in Cy40h are: ECOCLIMAP v2.2, the FAO 10 km resolution sand and clay database, and the GMTED2010 250m resolution orography, and the Global Lake DataBase (GLDB). We will continue to critically examine these databases when reasons for doing so are brought up by verification scores. Eventual modifications done on regional/domain level will be gathered to consortia wide versions of these databases. In collaboration with the SURFEX team at Météo-France such modifications may also lead to official updates of these databases, as published via the SURFEX web site by Météo-France.
In specific projects, as e.g. the HIRLAM efforts to set up test areas at 1 km resolution, the ECOCLIMAP-SC (Second Generation) physiography, as currently developed by Météo-France, will be examined. The style of ECOCLIMAP-SC simplifies the possibility to complement with higher resolution and/or more accurate physiography data based on e.g. national databases.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU5.1	Compile common consortia wide versions of physiography databases based on regional/domain specific modifications.	BoPa, EkKo, JodVr, PaSa, MaHo, SuPa, SaVi	database
SU5.2	In collaboration with the SURFEX team, perform eventual updates of SURFEX web-site publically available physiography databases when it is considered suitable.	EkKo, PaSa	database
SU5.3	Participate in ECOCLIMAP-SC database developments, utilize and examine it for 1 km resolution test domains. Participate in the lake database developments.	PaSa, EkKo	report, configuration, database
SU5.4	Test of ECOCLIMAP-Second Generation in the high-resolution test domains (see HR1) and, when considered relevant, complement the databases with more accurate information based on e.g. national data.	PaSa, SaVi, KPNi	report, database
SU5.5	Document IMO projects related to ECOCLIMAP/PGD development	SiTh	report

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU5.1	EkKo, PaSa	updated databases	End of 2018
SU5.2	EkKo, PaSa	updated databases	End of 2018
SU5.3	PaSa, EkKo	report, namelist configuration	End of 2018
SU5.4	PaSa	report, updated databases	Mid 2019
SU5.5	SiTh	report	End of 2018

ALADIN/HIRLAM/LACE WorkPackage description : SU6

WP number	Name of WP
SU6	Coupling with sea surface/ocean
WP main editor	**Jure Cedilnik**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MaLi, PeSm, BeSt, JuCe, NePr	Matjaž Ličer, Peter Smerkol, Benedikt Strajnar, Jure Cedilnik, Neva Pristov (0.75, 4, 0.5, 0.5, 0.25)	ARSO Slovenia	6
MDS, MaTu	Mathieu Dutour Sikirić (2 external), Martina Tudor(1)	DHMZ Croatia	3
LiWu	Lichuan Wu (3 + MetCoOp* + CARRA*)	SMHI Sweden	3

WP objectives

Assess and improve quality of surface characterization:
- Currently the sea surface is treated as a boundary condition represented by a rough surface (surface roughness but without waves) whose temperature is prescribed from other models and/or analysis. Our aim is to explore the benefits of a more realistic sea-atmosphere coupling where the state of the sea surface is allowed to evolve with time during the forecast (e.g. temperature and waves) through coupling of the atmosphere with an ocean or sea surface model.

The aim is to establish a three-way ocean-atmosphere-wave coupling system where the interaction between sea surface and ocean is used. So far this has been achieved using ALARO CMC, Princeton Ocean Model (POM) and WAM with OASIS coupler. The coupling is performed on the level of fluxes every time step and all three binaries are running together in parallel.
- Current code (the developments on the atmospheric part ALARO CMC) should be phase with a newer cycle, similar set of procedures prepared for AROME, HARMONIE-AROME. Coupling of wave model through SURFEX can be also verified.
- A good starting point is to test ocean-atmosphere and atmosphere-wave coupled system separately.

Extensive validation has been already performed for 2-way ocean-atmosphere coupling (ALARO CMC, POM) from both ocean and meteorological points of view. Further plan is to replace POM with NEMO model.
Preliminary studies of coupling HARMONIE-AROME with WAM have indicated possible benefits for the description of surface drag and winds over sea.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU6.1	Code and Technical documentation of coupling process		
SU6.1.1	Adaptations on atmospheric part ALARO	PeSm	t-code
SU6.1.2	Adaptations on atmospheric part HARMONIE-AROME		t-code
SU6.1.3	Technical documentation	PeSm	documentation
SU6.2	Construct cycling with OASIS coupler in cy38	PeSm, JuCe	code (local)
SU6.3	Replace POM with NEMO in ALADIN/SI system	MaLi, PeSm	code/script
SU6.4	Evaluation of coupled system ALADIN/NEMO	MaLi, BeSt, JuCe	report/paper
SU6.5	Implementation of ocean wave model		
SU6.5.1	Wave model WAM coupled via OASIS	PeSm, JuCe	code (local)
SU6.5.2	Assess the existing wave models and make recommendation for which one to implement in the ALADIN-HIRLAM system. Also recommend coupling strategy, e.g. direct subroutine call from SURFEX or via coupler OASIS.	LiWu	report
SU6.5.3	Implementation of wave model into the ALADIN-HIRLAM system.	LiWu	
SU6.5.4	Coupling and implementation of wave model WWM in ALARO	MDS, MaTu	report
SU6.6	Set-up of coupled system ALADIN/NEMO/WAM	MaLi, BeSt, JuCe	

t-code deliverables

Task	Responsible	Cycle	Time
SU6.1.1		cy4?	
SU6.1.2		cy4?	

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU6.1	PeSm	Documentation, code	2017
SU6.2	PeSm	Algorithm, code	2016
SU6.3	MaLi	Paper, scripts	2018
SU6.4	MaLi	Report/paper	End of 2019
SU6.5.2	LiWu	Report	Mid 2018

ALADIN/HIRLAM/LACE WorkPackage description : E1

WP number	Name of WP
E1	Arome-France EPS (PEARO)
WP main editor	**Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
LR, LD, LRo, PA, YM, PC, CL	Laure Raynaud, Laurent Descamps, Lucie Rottner, Philippe Arbogast, Yann Michel, Pierrick Cébron, Carole Labadie : CNRM/GMAP (9.5, 2.5, 6.5, 2, 1, 1, 1)	Météo-France	23.5
FBt, HM, SR	François Bouttier, Hugo Marchal, Sabine Radanovics (ext) : CNRM/GMME (11, 11, 2)	Météo-France	24
OM, MZ, MT, HP	Olivier Mestre, Michael Zamo, Maxime Taillardat, Harold Petithomme : DirOP/COMPAS (1, 1, 1, 1)	Météo-France	4

WP objectives

Operational maintenance and improvement of the MF convection-permitting EPS system PEARO. Development of post-processing products. Scientific evaluation and investigation of novel ideas.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E1.1	Maintenance and evolution of the PEARO system: evaluate 4 runs per day, follow adaptations for e-suites	LR	non-t-code
E1.2	Probabilistic post-processing (including probabilistic objects), calibration and verification	LR, LRo, PA, OM, MZ, MT, HP, FBt, HM, SR	non-t-code
E1.3	Link with AEARO: use Arome EDA perturbations in PEARO initial conditions	LR, YM, FBt	non-t-code
E1.4	Model perturbations for PEARO: assess SLHD, SPPT, SPP etc.	LR, LD, FBt	t-code
E1.5	Improvements of the global EPS (PEARP), as the coupling system of PEARO	PC, CL	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E1.4	LR		
E1.5	PC		

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E[1-5]	MF scientific staff	scientific notes and papers, namelists	

ALADIN/HIRLAM/LACE WorkPackage description : E2.1

WP number	Name of WP
E2.1	Development of convection-permitting ensembles: HarmonEPS - Physics perturbations
WP main editor	**Inger-Lise Frogner**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
AlCa	Alfons Callado	AEMET Spain	3
XiYa	Xiaohua Yang	DMI Denmark	0.5
PiOl	Pirkka Ollinaho	FMI Finland	2
MaLa	Marko Laine	Helsinki University	2 (ext)
SvdV, JaBa	Sibbo van der Veen, Jan Barkmeijer (3, 1)	KNMI Netherlands	4
AlHa	Alan Hally	MET Eireann	2.5
ILF	Inger-Lise Frogner	MET Norway	2
GeSm	Geert Smet	RMI Belgium	0.5
UlAn	Ulf Andrae	SMHI Sweden	1

WP objectives

Study ways to represent uncertainty in the atmospheric model and how to best incorporate this into HarmonEPS. Several methods for this will be further developed and assessed in 2018:
-The SPPT scheme will be tested more extensively, and various options for improvement will be explored.
-Work on introducing stochastic perturbations at the process level will continue. The SPP approach (Stochastically Perturbed Parametrization scheme) will be followed, where sensitive parameters are perturbed using a spatio-temporal pattern.
-Multi-physics, in which each member of the ensemble has its unique set of predefined parameterization schemes and/or parameters, has also shown to give promising results, and will be further investigated.
In the long run, what would probably be the best approach to describe the uncertainty in upper air physics, is truly probabilistic parameterization schemes.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.1.1	SPPT: Testing in HarmonEPS. Investigate and correct the current problem with the pattern generator. Look into new ways of constructing SPPT, by eg independent perturbations of partial tendencies. Compare and combine with other perturbation techniques. Developed in the context of 4DVAR, there is the possibility to determine favourable tendency perturbations. For example, to induce vertical wind. In the context of triggering convection this may be beneficial.	AlCa, JaBa	t-code
E2.1.2	Parameter perturbations: EPPES (ensemble prediction and parameter estimation system) developed in Finland will be used to find optimal values for sensitive parameters, and their PDF's, which in turn will be used for perturbing the parameters using a spatio-temporal correlation pattern (SPP-approach). Currently the SPPT pattern generator is under investigation, and this will continue in 2018. In reality, longer spatial scales live longer than shorter spatial scales, and if time permits in 2018 we will consider introducing the "Spatio-temporal stochastic pattern generator" (SPG, Tsyrulnikov). This can be done cooperating with Mihaly Szucs who is working on the implementaion from the Aladin side.	SvdV, UA, IF, PO, MaLa, AH, JB	t-code
E2.1.3	Multiphysics has been used in the COMEPS at DMI. The scheme appears to have contributed to a generally satisfactory spread in COMEPS system, but the impact of the multi-physics scheme needs further investigation. A further extension of reasonable parameterisation mix is also to be further explored.	XiYa, GeSm	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.1.1	AlCa	CY43h	End 2018
E2.1.2	UlAn	CY45h	End 2019

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.1.3	XiYa	HarmonEPS configuration test (namelist changes)	End 2018

ALADIN/HIRLAM/LACE WorkPackage description : E2.2

WP number	Name of WP
E2.2	Development of convection-permitting ensembles: HarmonEPS - Initial conditions perturbations
WP main editor	**Inger-Lise Frogner**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PaEs	Pau Escriba	AEMET Spain	4
XiYa	Xiaohua Yang	DMI Denmark	0.5
JaBa	Jan Barkmeijer	KNMI Netherlands	
ILF, RoRa	Inger-Lise Frogner (0.5), Roger Randriamampianina (ext)	MET Norway	0.5
MiVa	Michiel Vanginderachter	RMI Belgium	3
JeBo, AkJo	Jelena Bojarova, Åke Johansson (3, 2)	SMHI Sweden	5

WP objectives

EDA will be further tested in 2018. LETKF is now working, and EDA, LETKF and perturbations to the whole control vector (Brand) will be tested and compared. New cycling strategies will be tested and spin-up behavior will be studied. The challenge of creating equally likely ensemble members will continue in 2018.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.2.1	EDA in 3D-Var: Investigate optimal number of members in EDA. Test the combination of EDA with mesoscale surface perturbations, and the combination of EDA with default initial perturbations from IFS (ENS or High Res in SLAF).	ILF, RoRa	Non-t-code
E2.2.2	LETKF: Testing and tuning of LETKF in HarmonEPS.	JeBo, PaEs	Non-t-code
E2.2.3	Continue the development of Random perturbations of the control vector with the structure of the B-matrix (Brand).Random perturbations are added to the analysis of the control member, or to the first guess, and evolved by the non-linear model. An algorithm for inflating the perturbations will be developed. The ensemble will be evaluated using probabilistic and deterministic scores, as well as in structure functions space.	JeBo	t-code
E2.2.4	Compare ensemble performance with different types of initial perturbations: EDA, L(ETKF), forcing perturbations and perturbations based on Brand	JeBo, PaEs	Non-t-code
E2.2.5	Analyse behavior of spin-up and effects on perturbation in connection with different approaches for generation of frequent control analysis by cycled or uncycled configuration, the former with the current HarmonEPS, the latter through use of overlapping assimilation windows as used in DMI-COMEPS. For such study, a rapid refreshing analysis with up to sub-hour frequency will be tested.	XiYa	Non-t-code
E2.2.6	Study the error propagation mechanism on meso-scales and how to generate perturbations which represent the error growth, by use of eg. singular vectors and looking in their applicability at the meso scale.	JaBa, MiVa	t-code
E2.2.7	Continue study of the problem of creating equally likely initial conditions/ensemble members	AkJo	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.2.3	JeBo	CY43h	End 2018
E2.2.6	JaBa	?	?
E2.2.7	AkJo	?	?

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.2.1	ILF and RoRa	HarmonEPS configuration test	End 2018
E2.2.2.	PaEs	HarmonEPS configuration test	End 2018
E2.2.4	JeBo	HarmonEPS configuration test	End 2018
E2.2.5	XiYa	HarmonEPS configuration test	End 2018

ALADIN/HIRLAM/LACE WorkPackage description : E2.3

WP number	Name of WP
E2.3	Development of convection-permitting ensembles: HarmonEPS - Surface perturbations
WP main editor	**Inger-Lise Frogner**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
AlGa	Alberto Garcia	AEMET Spain	
HeFe	Henrik Feddersen	DMI Denmark	1
JaKa	Janne Kauhanen	FMI Finland	2
JdV	John de Vries	KNMI Netherlands	0.5
AnSi, RG	Andrew Singleton, Rafael Grote (5, 3)	MET Norway	8
GeSm	Geert Smet	RMI Belgium	1.5
BjSt	Björn Stensen	SMHI Sweden	3

WP objectives

Incorporate and assess surface perturbations in HarmonEPS:- Continue to study the surface field perturbation code from Meteo-France and possible waysto improve this- Perform offline studies with perturbations in the parametrizations for surface momentum,heat and moisture fluxes.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.3.1	Surface perturbations: continue to work on the surface perturbation code from MF. Particularly try different scales for different parameters, as different parameters have different “memory” and hence should have different scales. Try more sophisticated SST perturbations, to introduce perturbations where the uncertainty is believed to be largest (eg in sharp gradients of SST).	AnSi, BjSt,HeFe,AlGa, GeSe	t-code
E2.3.2	Surface physics: Continue study of perturbations in momentum, heat and moisture flux parameterizations. Run SURFEX 1D experiments with different formulations for the roughness length for heat and moisture over different vegetation types. Use results of these experiments to determine perturbation magnitudes for the roughness length for heat and moisture in HarmonEPS experiments.	AnSi, JdV?	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.3.1	AnSi	CY45h	2019
E2.3.2	AnSi	CT45h	2019

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : E2.4

WP number	Name of WP
E2.4	Development of convection-permitting ensembles: HarmonEPS - Lateral boundary perturbations
WP main editor	**Inger-Lise Frogner**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
HeFe	Henrik Feddersen	DMI Denmark	1.5
ILF	Inger-Lise Frogner	MET Norway	0.5

WP objectives

Lateral boundary conditions are important for the performance of ensemble systems with relatively small integration domains, such as commonly used for HarmonEPS. Scaled lagged averaging (SLAF) has proven easy to implement in HarmonEPS, is computationally efficient, provides higher resolution than can be achieved when taking lateral boundary conditions from EC ENS, and verifies well. However, the number of members available with SLAF is limited and some unrealistic clustering of members is seen. EC ENS is presently available at higher spatial and temporal resolution than was the case when SLAF was introduced, and experiments comparing SLAF and ENS will continue in 2018.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.4.1	SLAF and random field perturbations have shown as good as or better performance than LBCs and initial perturbations as EC-EPS. Study if this is due to non-optimal use of EC-EPS perturbations. Test possibility to improve ensemble spread by a transform of the EC-EPS boundaries (orthogonalize initial perturbations) and/or by inflation.	HeFe	Non-t-code
E2.4.2	Clustering: Test the new EC-EPS boundaries (four times a day and hourly output) combined with inflation and using the clustering algorithm from COSMO that selects what ENS members to nest HarmonEPS members in. Compare with SLAF.	ILF	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.4.1	HeFe	Algorithm	End 2018
E2.4.2	ILF	HarmonEPS configuration test	End 2018

ALADIN/HIRLAM/LACE WorkPackage description : E2.5

WP number	Name of WP
E2.5	Development of convection-permitting ensembles: HarmonEPS - HarmonEPS system
WP main editor	**Inger-Lise Frogner**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
XiYa, HeFe	Xiaohua Yang, Henrik Feddersen (for publication E2.5.7): (0.5, 0.25)	DMI Denmark	0.75
PiOl	Pirkka Ollinaho	FMI Finland	1
OlVi, ILF	Ole Vignes, Inger-Lise Frogner (for publication E2.5.7): (1, 1)	MET Norway	2
GeSm	Geert Smet	RMI Belgium	1
UlAn	Ulf Andrae	SMHI Sweden	1

WP objectives

Provide continuous support for the implementation of new HarmonEPS developments.
Create a new EPS branch based on cy40h1.2, which will enable easier start of experiments from spin-up data, and to be used for further developments. Introduce a new boundary strategy that can utilize operational EC ENS (which is not archived in MARS, but which is now available in a short-term running archive), and with this also implement the COSMO clustering algorithm. The EPPES approach for estimating optimal parameters and their distribution, will be an important task in 2018. This will be used in the parameter perturbation approach described in E2.1.
Prepare and submit a paper as scientific documentation on the HarmonEPS system and its operational implementations.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.5.1	Make a HarmonEPS branch from CY40h1.2	UlAn	Non-t-code
E2.5.2	Easier start of experiments from spinup data	OlVi	Non-t-code
E2.5.3	New boundary strategy using operational ENS data	UlAn	Non-t-code
E2.5.4	Introduce clustering code	UlAn	Non-t-code
E2.5.5	Introduce EPPES in HarmonEPS	UlAn, PiOl	t-code?
E2.5.6	Where needed, introduce system changes to support required HarmonEPS developments	OlVi, UlAn	
E2.5.7	Prepare and submit a paper giving a scientific description of HarmonEPS, the perturbation strategies available in it, a description of two operational implementations of HarmonEPS (MEPS and COMEPS), and a comparison of the performance of these two systems over a common domain.	ILF, UlAn, XiYa, GeSe	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.5.5	UA	CY45h	2019

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.5.1	UlAn	HarmonEPS configuration	Early 2018
E2.5.2	OlVi	HarmonEPS scripts	Early 2018
E2.5.3	UlAn	HarmonEPS scripts	End 2018
E2.5.4	UlAn	HarmonEPS scripts	End 2018
E2.5.6	OlVi, UlAn	Support	Cont.
E2.5.7	ILF	Publication	Summer 2018

ALADIN/HIRLAM/LACE WorkPackage description : E3

WP number	Name of WP
E3	Development of convection-permitting ensembles: LACE
WP main editor	**Martin Belluš**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MiSz	Mihály Szűcs	OMSZ Hungary	2
ReSu	Reka Suga	OMSZ Hungary	4
ChWi	Christoph Wittman	ZAMG Austria	1
ClWa	Clemens Wastl	ZAMG Austria	7
FlWe	Florian Weidle	ZAMG Austria	2
JoKe	Josef Kemetmüller	ZAMG Austria	1

WP objectives

Development of convection-permitting ensemble system based on non-hydrostatic AROME model. The aim would be to probabilistically forecast high-impact weather on local spatial scales and with short life-cycle.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E3.1	Development and implementation of new random number generator (SPG) suitable for LAM EPS environment.	MiSz	t-code
E3.2	Consider the implementation of 3D version of new SPG to have vertical structure for random patterns and also a non-Gaussian noise distribution option.	MiSz	non-t-code
E3.3	Continue work on stochastic perturbation of physics tendencies as a tool to simulate the model uncertainty, with the usage of improved random number generator. Test and evaluate the different options of model perturbation (e.g. parameter/process based stochastic physics for AROME).	ClWa, ReSu	t-code
E3.4	Perform the “cheap” parallel experiments with lagged convection-permitting ensemble system formed by several deterministic AROME runs (RUC).	ClWa, ReSu	non-t-code
E3.5	Implementation, tuning and testing of pre-operational AROME based EPS system	FlWe, ChWi, ClWa	

t-code deliverables

Task	Responsible	Cycle	Time
E3.1	MiSz, ChWi	CY40T1	end of 2017
E3.3	ClWa	?	2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E3.2	MiSz	feasibility study	2018
E3.4	ChWi	scripts, verification results	2018

ALADIN/HIRLAM/LACE WorkPackage description : E4

WP number	Name of WP
E4	Development, maintenance and operation of LAEF
WP main editor	**Martin Belluš**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
IOP	Iris Odak Plenković	DHMZ Croatia	1.5
SiSb	Siham Sbii	Maroc Meteo	6
SiTa	Simona Tascu	Meteo Romania	2
RaIo	Raluca Iordache	Meteo Romania	1.5
CaKa	Canbert Karadavut	MGM Turkey	1
MaBe	Martin Belluš	SHMU Slovakia	4
MaDi	Martin Dian	SHMU Slovakia	2
ChWi	Christoph Wittman	ZAMG Austria	0.5
FlWe	Florian Weidle	ZAMG Austria	0.5

WP objectives

ALADIN-LAEF research and development. Achieved results, new tested implementations and gained expertise are going to be used for the further improvement of our regional ensemble forecasting system. The second objective of this task is to maintain and monitor the operational suite of ALADIN-LAEF running at ECMWF HPC facility. Stable operational suite of ALADIN-LAEF system is guaranteed and the delivery of probabilistic forecast products to the LACE partners is ensured. The R&D achievements are being presented at the workshops and published in the scientific journals.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E4.1	Testing the ALARO-1 physics and its different tunings. Use of the most suitable set of 4 different configurations (at maximum) with altered settings for microphysics, turbulence and deep convection and construct a 16-member ensemble out of their combinations. Ensure model stability.	ChWi, RaIo, MaBe, CaKa	non-t-code
E4.2	Supplement reduced multi-physics with the stochastically perturbed physics tendencies (using newly developed and implemented random pattern generator) for the upper-air and surface prognostic variables.	MaBe	t-code
E4.3	Perform detailed scientific validation and tuning of the 3DVar within ALADIN-LAEF framework in order to be used in ENS BlendVar.	MaBe, SiTa	non-t-code
E4.4	Investigate different approaches for the creation of background model statistics (B-matrix) in the EPS framework, e.g. flow-dependent B-matrix can be recomputed regularly every couple of weeks with very little costs. Test its impact on ALADIN-LAEF performance.	MaBe	non-t-code
E4.5	Operational implementation of ALADIN-LAEF 5 km and its components (IC: ESDA; model: SPPT+ALARO-1 MP) - phase I.	FlWe, MaBe, ChWi	non-t-code
E4.6	Operational implementation of ALADIN-LAEF 5 km and its components (IC: ENS BlendVar) - phase II.	MaBe, ChWi	non-t-code
E4.7	Test the benefits of ensemble calibration and post processing of high resolution ALADIN-LAEF wind forecast.	IOP	non-t-code
E4.8	Investigate ways for an ensemble forecqsting with AROME-MAROC	SiSb	

t-code deliverables

Task	Responsible	Cycle	Time
E4.2	MS, MaBe	CY40T1	end of 2017

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E4.1	RaIo, MaBe, ChWi	namelists, verification	end of 2017
E4.3	MaBe, SiTa	report, namelist, verification	2018
E4.4	MaBe, SiTa	perl scripts, scientific study	2018
E4.5	FlWe, MaBe, ChWi	operational scripts	end of 2017
E4.6	FlWe, MaBe, ChWi	operational scripts	end of 2018
E4.7	IOP	report, scientific study	end of 2017

ALADIN/HIRLAM/LACE WorkPackage description : E5

WP number	Name of WP
E5	Production and maintenance of GLAMEPS
WP main editor	**Inger-Lise Frogner**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
ToMo	Toon Moene	KNMI Netherlands	1

WP objectives

GLAMEPS will continue in operations until June 2019. No updates to the system will be done, only necessary maintenance to keep it in operations.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E5.1	GLAMEPS maintenance	ToMo	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E5.1	ToMo	System maintenance	June 2019

ALADIN/HIRLAM/LACE WorkPackage description : E6

WP number	Name of WP
E6	Ensemble calibration
WP main editor	**Inger-Lise Frogner**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
KaHa	Karoliina Hämäläinen	FMI Finland	ext
KiWh, MaSc	Kirien Whan, Maurice Schmeits (3,1)	KNMI Netherlands	4
JBB, ThNi	John Bjørnar Bremnes, Thomas Nipen (2, 1)	MET Norway	3

WP objectives

Statistical calibration of LAM EPS data is a way of reducing model-specific systematic errors in areas with adequate observation coverage. For establishing statistical significance for the forecasting of severe (rare) events, ideally one should use ensemble re-forecasting over a climatologically relevant period (~30 years). However, this is prohibitively costly in terms of computer resources. We have therefore adopted simpler forms of calibration, which may be less capable of accounting for weather extremes, or perform less well in spatially heterogeneous terrain. In its present implementation in both GLAMEPS and HarmonEPS, calibration is done for screen-level temperature and wind and precipitation. Spatially variable corrections are applied over the entire grid, not only in observation points, as it is seen as important to have calibrated forecasts everywhere and not only at observation sites. In spatially highly heterogeneous conditions, e.g. in mountain areas or at land-sea transitions, calibration is still problematic. Attention will be paid to the introduction of more advanced methods which are better capable of handling areas of such strong spatial inhomogeneity, as well as to the extension of the calibration to a wider range of parameters, such as visibility and gusts. Also, calibration for observation points only will be experimented with, as this may give an appreciable gain in forecast quality for forecasts in those specific locations, as compared to field calibration.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E6.1	Adapt the calibration methods so that local variations in heterogeneous landscapes are better represented in HarmonEPS and GLAMEPS. For this, both more detailed orographic information is needed and more advanced methods need to be developed.	JBB, KiWh, MaSc, ThNi	Non-t-code
E6.2	Extend calibration to more parameters (clouds, wind gust).	JBB	Non-t-code
E6.3	Develop site calibration for visibility for airport locations, as visibility is a crucial forecast parameter for aviation, and one for which most likely it will be very difficult to achieve a useful calibration of the whole grid.	JBB	Non-t-code
E6.4	New parameters related to solar energy (surface solar radiation) will be tested. The IFS-ENS and MEPS forecasts will be verified and calibrated against observations from 25 Finnish stations.	KaHa	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E6.1	ThNi	Calibration code	2018
E6.2	JBB	Calibration code	2018
E6.3	JBB	Calibration code	2018
E6.4	KaHa	Calibration code	2018

ALADIN/HIRLAM/LACE WorkPackage description : QA1

WP number	Name of WP
QA1	Development of HARP
WP main editor	**Christoph Zingerle**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
BHS	Bent Hansen Sass	DMI Denmark	0.5
AnSi	Andrew Singleton	MET Norway	2
AlDe	Alex Deckmyn	RMI Belgium	3
ChZi	Christoph Zingerle	ZAMG Austria	2

WP objectives

HARP (Hirlam-Aladin R-package) has been established with the aim of a common development of verification tools.In a first step, a toolbox for EPS and spatial verification should be established based on already existing standard R-packages, R-packages developed in consortia institutes (e.g. for handling Grib and other specific spatial data formats, re-griding, …) and a number of specific R-routines. A first version of HARP (v.1) has been released in 2015 containing a variety of tools for EPS verification. This was followed by the release of HARP-v2 in 2017, containing an update and thorough cleaning of the EPS verification, as well as a first version of a spatial verification tools. For the time being, the EPS and spatial parts of HARP are set up separately.
In 2018 and later, a continuous assessment, improvement and (where needed) extension of the EPS and spatial verification methods and tools will take place according to user demand. The aim is to provide an extended version of HARP (v3) around the end of 2018, including spatial verification of ensembles, treatment of combined probabilities, and with deterministic verification against in-situ observations. The latter will thereby permit HARP to eventually replace the existing, separate, deterministic verification packages used within ALADIN and HIRLAM. Furthermore, a complete update or re-shape of the installation process will be necessary in the coming years, as there will be fundamental changes in the HARP specific R-packages. It is planned to update the scripts and configuration so it can be run using R only. In Addition it is aimed to merge the currently different setups of the EPS and spatial parts of HARP and converge them into one single system in the next few years.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
QA1.1	Convergence of EPS and spatial inherits an update of the EPS and spatial scripts to be used in a common setup. Also the installation process will be updated as there are more HARP-specific R-packages and configuration files used by both parts.	AlDe, AnSi, ChZi, BHS	code
QA1.2	Work on HARP v3 will focus to the extension to deterministic point verification tools. Furthermore there will be efforts taken to make use of ECMWF analysis and the treatment of combined probabilities in EPS verification. An updated documentation for installation and usage of HARP v3 on ecgate and locally will be necessary.	AlDe, AnSi, ChZi, BHS	code
QA1.3	Implementation in HARP v4 of the developments in WP QA2, task 2.3 (development of new verification methods/metrics – spatial verification of EPS's) and 2.4 (spatial structures relative to ECMWF)	AlDe, AnSi, ChZi, BHS	code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
QA1.1	AlDe, AnSi, ChZi	Installation and usage of the different branches of HARP (EPS and spatial) will converge. There will be only one toolbox.	2018
QA1.2	AlDe, AnSi, ChZi	Tools for deterministic verification are available. They are integrated in the existing code of spatial and EPS verification.	End 2018
QA1.3	AlDe, AnSi, ChZi	Code for spatial tools for EPS will be available in the same manner as for the spatial and EPS parts.	2020

ALADIN/HIRLAM/LACE WorkPackage description : QA2

WP number	Name of WP
QA2	Development of new verification methods
WP main editor	**Christoph Zingerle**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
BHS, HeFe	Bent Hansen Sass, Henrik Feddersen (0.5, 3)	DMI Denmark	3.5
HDV, SvdV	Hylke de Vries, Sibbo vd Veen (1, 2)	KNMI Netherlands	3
AnSi, MoKo	Andrew Singleton, Morten Køltzow (1, 1)	MET Norway	2
AlDe	Alex Deckmyn	RMI Belgium	1
AkJo	Åke Johansson	SMHI Sweden	1
ChZi	Christoph Zingerle	ZAMG Austria	2

WP objectives

Development of convection permitting EPS's has has reached a stage, where such systems are going to be operationally implemented at different national institutes. For such models/systems, existing EPS-point verification methods are not sufficient to grasp forecast quality in detail, especially when it comes to the problem of verifying different processes in clouds, convection and precipitation formation. Furthermore, the density of standard meteorological observation networks, ground based or based on radiosondes, is far too wide to represent the scale of convection permitting models or EPS's.
High resolution spatial observations, such as radar and satellite data, can provide important information on the 3D-structure of the atmosphere and compared to that of the convection-permitting models or ensembles, even though these data sources each have their own limitations. In the development of new verification techniques, a focal point will be to use more information about clouds, precipitation and convection from satellite and radar data (task QA2.1).A second target is to extend existing spatial verification methods developed for deterministic models to high-resolution EPS systems in a number of steps (tasks QA2.2, 2.3 and 2.5). One simple approach would be to verify EPS against ECMWF analyses. This may be useful particularly in data sparse areas (QA2.4).In the past years, score cards have been developed for the deterministic model to provide a quick overview of forecast quality. These score cards will be extended with new scores, e.g. considering spatial and ensemble verification (QA2.6)
Theoretical studies to understand the limitations of currently used (skill assessment of) ensemble prediction systems will be continued (QA2.7)

Descriptions of tasks

Task	Descriptiong	Participant abbrev.	Type of deliverable
QA2.1	A wide range of information on the atmospheric state is already operationally available from meteorological satellites (SAF's) and weather radars, while other information is not yet routinely produced. As a first step, the available data and their potential usefulness for spatial-probabilistic verification will be screened and documented.	ChZi	documentation
QA2.2	A number of spatial verification methods has been developed, mainly dealing with precipitation verification. Code is available and will be reviewed for its potential for further development into methods for spatial-probabilistic verification. There will be a focus on the possible usage of information from radar and satellite data other than what is used in spatial precipitation analysis.	ChZi	documentation
QA2.3	As an outcome of QA2.1 and QA2.2, a good knowledge of available data and methods suited for development of spatial-probabilistic verification is documented. This will be the basis for the development of (a) new verification method(s), aiming to providing deeper insight into the ability of the model/EPS system to represent the 3-D state of the atmosphere and the processes determining cloud, convection and precipitation formation.	ChZi, AlDe	code
QA2.4	Include new metrics to characterize spatial structure of forecasts relative to ECMWF analysis. After successful implementation and test prepare transfer of these metrics to HARP.	HeFe, BHS, AlDe	Develop and test code, document results (common code for HIRLAM and ALADIN)
QA2.5	Extend appropriate spatial verification techniques towards use in EPS. Use spatial verification (FSS) to determine upscaling/ neighbourhood radius. Locally varying neighbourhood sizes needs to be considered, e. g. following Dey et al (QJRMS, 2016), to improve probability forecasts for small ensembles. Test for Norway using prototype 1h precipitation analyses that blend radar and gauges. Compare upscaling and neighbourhood methods. (New results from QA2.2 and QA2.3 will be used when relevant)	AnSi, HeFe, SvdV, BHS	Develop and test code, document results (common code)
QA2.6	Adapt score cards to new verification parameters or measures i) for deterministic forecasts excluding spatial verification, e.g. based on vobs/vfld files. ii) to spatial verification and probabilistic verification.	MoKo, HDV	For i) scripts /code mainly used in HIRLAM For ii) scripts/code (common code for HIRLAM and ALADIN)
QA2.7	Theoretical studies, e.g. to understand limitations of the currently used ensemble prediction systems, e.g. further development of the U.UI spread-skill relationship: (i) the Desroziers et al. corrections, (ii) observation inhomogeneity in space and time, (iii) reconciling differences when verifying against observations vs analysis.	AnSi, AjJo	Code and reports documenting properties and limitations of current systems

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
QA2.1	ChZi	Documentation containing a list of satellite and radar data available and describing their potential information content to be used in spatial-probabilistic verification.	End 2018
QA2.2	ChZi	Documentation of recently developed methods for spatial verification. Focus is on their potential to be adapted or improved to be used in spatial-probabilistic verification.	Spring 2019
QA2.3	ChZi	Prototype code to be implemented in HARP for spatial-EPS verification (Q1.6)	End 2019
QA2.4	HeFe, BHS	Develop and test code, document results (common code for HIRLAM and ALADIN)	End 2018
QA2.5	AnSi, HeFe, SvdV	Develop and test code, document results (common code for HIRLAM-and ALADIN)	End 2018
QA2.6	MoKo, HDV	For i) scripts /code mainly used in HIRLAM , regarding ii) scripts and code for common HIRLAM-ALADIN code	End 2018
QA2.7	AkJo,AnSi	Code and reports documenting properties and limitations of current systems	End 2018

ALADIN/HIRLAM/LACE WorkPackage description : QA3

WP number	Name of WP
QA3	Quality assessment of new HARMONIE-AROME cycles and alleviation of model weaknesses
WP main editor	**Bent Hansen Sass**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
GeMo	Gema Morales	AEMET Spain	2
BHS, XiYa, BjAm	Bent Hansen Sass, Xiaohua Yang, Bjarne Amstrup (5, 0.5, 0.5)	DMI Denmark	6
MaKa	Markku Kangas	FMI Finland	2
BoPa	Bolli Palmason	IMO Iceland	0.5
SaTj, WdR	Sander Tijm, Wim de Rooy (1, 1)	KNMI Netherlands	2
EmGl	Emily Gleeson	MET Eireann	0.5
MoKo, RoRa	Morten Køltzow, Roger Randriamampianina (0.5, 0.5)	MET Norway	1
KII	Karl-.Ivar Ivarsson	SMHI Sweden	1

WP objectives

This work package concerns both the routine monitoring of operational Harmonie systems and the assessment of new model components and cycles under testing. Routine monitoring information is gathered from the Harmonie Regular Cycle of the Reference runs (RCR) and other operational suites, e.g. in the form of forecast charts, observation and field verification, observation usage and analysis statistics, meteograms and verification of boundary layer profiles against masts. The data portal on hirlam.org is used to monitor quality trends and observations usage statistics, and to detect deficiencies.
Prior to the release of new versions, extensive quality assurance tests are done for the RCR domains and as many other operational domains as is feasible. These verification results form the basis of the acceptance procedure of a new release candidate. Tools in the form of score cards add to the overview of quality differences between two model versions. Quality assessment reports will be written and made available to the HIRLAM members.
A group of national forecaster representatives is requested to provide information on model performance in general and on specific systematic model weaknesses observed by them (with example cases), on a quarterly basis. On the basis of this information, the HIRLAM-C management group sets up a program of actions to study the issues brought forward and coordinates actions to tackle them. The forecaster representatives group is given feedback on the status of these activities. The lists of most important forecasting issues, and the status of related scientific actions to alleviate them will be regularly updated.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
QA3.1	Coordinated pre-release quality assurance and monitoring of operational HARMONIE suites, esp. the RCR. Score cards will be used in this process. Continued emphasis will be on studying known model deficiencies and validation of proposed ways to alleviate them	BHS, GeMo,MoKo	Documentation of studies examining model weaknesses and model changes to alleviate weaknesses
QA3.2	Maintenance of the Hirlam data portal and extension of operational observation usage monitoring. Intercompare HARMONIE models against mast profiles for European sites.	TRA, MaKa	Code-or script changes which improves information on observation use, e.g. in the case that new observations are supported in data-assimilation. Document results of comparisons of HARMONIE against mast data.
QA3.3	Verification and validation reports for new cycles released	BHS	Documentation
QA3.4	Additional input to be supplied from national verification systems, e.g. special scores providing new independent aspects of verification during monitoring and QA	GeMo, BjAm, BoPa, SaTj, MoKo, EmGl, KII, BHS	Documentation
QA3.5	Quarterly communication with users on identified model deficiencies, to be documented inhirlam.org. A list of key forecasting issues identified with users will be maintained and a corresponding list of top scientific priorities in work plan will be adjusted to be consistent with the identified key forecasting issues.	BHS	Documentation
QA3.6	Ongoing actions to relieve key weaknesses: Results from various initiatives are reported.	SaTj, BHS, RoRa, KII, WIM, GeMo	Documentation

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
QA3.1	BHS	Documentation	Quarterly
QA3.2	TRA ?	Code, Documentation	Per 6 months
QA3.3	BHS	Documentation	Per 6 months
QA3.4	BHS	Documentation	Quarterly
QA3.5	BHS	Documentation	Quarterly
QA3.6	BHS	Documentation	Quarterly

ALADIN/HIRLAM/LACE WorkPackage description : SY1

WP number	Name of WP
SY1	Code optimization
WP main editor	**Daniel Santos**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
DaSa	Daniel Santos	AEMET Spain	1
JWP, PeBe, BHS	Jacob Weisman Poulsen, Per Berg, Bent Hansen Sass (1, 0.5, 1)	DMI Denmark	2.5
RoSt	Roel Stappers	MET Norway	
PhMa, REK, YoZh	Philippe Marguinaud, Ryad El Khatib, Yongjun Zheng (5, 2+1, 3)	Météo-France	11
KII	Karl-Ivar Ivarsson	SMHI Sweden	1.5

WP objectives

To identify and overcome bottlenecks for code performance, comprehensive profiling is needed for each new cycle. Additionally, the model should be regularly benchmarked on as massively parallel machines as are available, not only for the model as a whole, but also for individual “dwarves”, to assess where the greatest gains in efficiency may be made. In a massively parallel system, processor failure will likely occur regularly. Thus, benchmark tests should also assess how well the system can handle such failures and investigate the need for more sophisticated techniques to ensure fault-tolerance.
The factors affecting code scalability are quite complex. Expertise in this area is thin, and should be strengthened. Parallelization by means of MPI and OpenMP should be incorporated in all parts of the code in which this hasn't been (fully) done yet. Significant reductions in computational costs can presumably still be made by optimization of the code in terms of aspects like loop order; partnerships with relevant computing expertise centers will be sought to strengthen efforts there. Something that can also be examined is the impact of replacing double-precision computations with single-precision ones, in terms of both the reduction in computational costs and the consequences for meteorological performance.
One aspect that was fairly little studied until today (as of 2017) is the sensitivity of the code performance to memory latency and bandwidth.
A major bottleneck for scalability in any NWP model is the need for I/O: e.g. to read initial and boundary data and to write forecast fields at required intervals. This can be done more efficiently by using an I/O server or by dedicating specific nodes to I/O, by asynchronous I/O, and by minimizing I/O due to intermediate file format transformations.
The use of accelerators such as GPU’s (Graphical Processing Units) or the related Intel Mic architecture can provide the model with a speedup of a factor of about ~3-4, and has an interesting potential for reduction of energy consumption, at the cost of recoding (into CUDA or more simply by adding OpenAcc directives). In e.g. the ESCAPE project, work will be done to benchmark and optimize the IFS/AAAH code for use in HPC’s involving accelerators and mixed CPU-GPU architectures.

Descriptions of tasks

Task	Description	Participant abbrev.h	Type of deliverablei
SY1.1	Profiling and optimization: perform regular scalability measurements, preferably on agreed common datasets;	JWP, PeBe	Non-t-code
SY1.2	Consider parallel and sequential splitting	JWP, PeBe	Non-t-code
SY1.3	Continue the work on Fullpos-2 (in relation with OOPS actions)	REK, RoSt	T-code
SY1.4	Improve code design, interface and efficiency with optimizations of the input/output part and reducing memory bandwidth (removing useless initializations or copies) in particular when some routines of the physics are called.	REK	T-code?
SY1.5	ESCAPE contributions to profiling of dwarves and preparing the code for use on mixed CPU-GPU architectures	BHS	Non-t-code
SY1.6	Update RAPS benchmark with new cycles and extend it to 3D-Var configurations	DaSa	Non-t-code
SY1.7	Support external studies on new computer architectures (e.g. GPGPU’s) and on innovative programming languages related to these new architectures	DaSa	Non-t-code
SY1.8	Development and use of numerical performance simulators, enabling to simulate the scalability properties of parts of the NWP codes on various HPC architectures (this is a WP of ESCAPE)	PhMa, YoZh	non-t-code
SY1.9	Further studies with single-precision versions of the NWP codes for the forecast models	PhMa, other GMAP staff tbd	t-code

t-code deliverables

Task	Responsible	Cycle	Time
SY1.3	REK	CY45T1, CY46T1	2017-2018
SY1.9	PaMa	CY43T2, CY46T1?	2016-2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SY1.1	JWP	Code optimizations	2018

ALADIN/HIRLAM/LACE WorkPackage description : SY2

WP number	Name of WP
SY2	Maintenance and development of the Harmonie Reference System
WP main editor	**Daniel Santos**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
DaSa, AnHe, GM	Daniel Santos, Angeles Hernandez, Gema Morales (3, 2.5, 1.5)	AEMET Spain	7
HeFe, KaSa	Henrik Feddersen, Kai Sattler (?, 0.5)	DMI Denmark	0.5
NiSo	Niko Sokka	FMI Finland	3.5
ToMo, BeUl	Toon Moene, Bert van Ulft (1.5, 2)	KNMI Netherlands	3.5
MaKa	Martynas Kazlauskas, Rymvidas Jasinskas (1.5, 1.5)	LHMS Lithuania	3
EoWh	Eoin Whelan	MET Eireann	0.25
TrAs, OlVi	Trygve Aspelien, Ole Vignes (0.5 external, 0.5)	MET Norway	0.5
UlAn	Ulf Andrae	SMHI Sweden	1.5

WP objectives

The Harmonie Reference System consists of source code, scripts, utilities and documentation for deterministic and probabilistic forecasting. A robust Harmonie Reference System which is demonstrably suitable for operational use is the main deliverable of the Hirlam collaboration. In the Harmonie Regular Cycle of Reference (RCR), one or more member services undertakes the responsibility to adopt the latest full release of the Harmonie Reference System as their operational model. The role of the RCR is to ensure and demonstrate the technical and meteorological capability of the model in an operational environment. The responsibility to act as RCR center rotates among Hirlam services, in line with major new releases. Until 2016 the RCR commitment only involved the deterministic model, but as HarmonEPS is nowadays an integral part of the system it will be included in future RCR commitments as well.
The Reference System contains more than the Harmonie-Arome canonical model configuration code, which at present consists of the Fortran code of the forecast model. The efforts on maintenance of the CMC part of the Reference System are part of the activities on maintance and development of the common code, as described in WP COM2.The efforts on maintenance and development of the remaining components of the Harmonie reference System (data assimilation and EPS code and scripts, the scripting system and related utilities) are described in this work package.
Pre-release testing of new Reference releases is done at least on the RCR operational model domains. With the aim to reduce the gap between the Reference system and operational implementations at member services, a more direct and wider staff involvement is sought in coordinated pre-release porting, testing and tuning.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SY2.1	Consult Hirlam services on agreements to run a Harmonie RCR for Harmonie-43h1 and future cycles	DaSa	Non-t-code
SY2.2	Implementation, monitoring, pre-release validation and testing, release and maintenance of non-CMC parts of the Reference System; support of the Reference system at one or more operational platforms.	DaSa, UlAn, OlVi, TrAs, NiSo, EoWh, HeFe, BoPa, MaKa	Non-t-code
SY2.3	Work on backup and trouble-shooting guidelines to ensure smooth operational running	DaSa, UlAn, OlVi, TrAa, EoWh, NiSo, HeFe, BoPa, MaKa	Non-t-code
SY2.4	Test injection of observation data at ECMWF and operational platforms running RCR	DaSa, UlAa, OlVi, NiSo, GM	Non-t-code
SY2.5	Ensure platform equivalence between the Reference system at ECMWF and operational RCR platforms on meteorological aspects	DaSa, UlAn, OlVi, TrAs, EoWh, NiSo	Non-t-code
SY2.6	Implement GRIB2 encoding of atmospheric and surface fields (UERRA*)	UlAn	Non-t-code
SY2.7	Continued ECFLOW support and increased capabilities	DaSa, OlVi, AnHe	Non-t-code
SY2.8	Prepare a move to GIT as the major version control system in Cy43h.	KaSa	Non-t-code
SY2.9	Arrange training in Harmonie and its components for newcomers if/when needed.	DaSa	Non-t-code
SY2.10	Design, implementation and validation of tool to generate MSG SEVIRI synthetic images.	AnHe	Non-t-code
SY2.11	Support by system group on porting Harmonie-Arome to different platforms ans ensuring platform equivalence	DaSa, UlAn, NiSo	Non-t-code
SY2.12	Maintenance and troubleshooting support for Harmonie-Arome by system group (e.g. through forum)	DaSa, UlAa, NiSo, EoWh	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SY2.2	DaSa	Code, Scripts	2018
SY2.6	UlAn	Code, Documentation	Early 2018
SY2.7	OlVi	Scripts	2018

SY2.10	AnHe	Scripts, Code, Documentation, Paper.	2018
SY2.11	DaSa	Scripts and code	continuous
SY2.12	DaSa	Documentation	continuous

ALADIN/HIRLAM/LACE WorkPackage description : SY3

WP number	Name of WP
SY3	Revision of the Harmonie scripting system
WP main editor	**Daniel Santos**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
DaSa, AnHe	Daniel Santos, Angeles Hernandez (1, 0.5)	AEMET Spain	1.5
SaSa	Sami Saarinen	FMI Finland	external
BoPa	Bolli Palmason	IMO Iceland	1
MaKa	Martynas Kazlauskas, Rymvidas Jasinskas (1.5, 1.5)	LHMS Lithuania	3

WP objectives

There are several reasons to perform an overhaul of the scripting system. Presently, the Harmonie scripting system uses a variety of scripting languages. This is confusing to users, and some languages used (e.g. Perl in the miniSMS scheduling system) are complicated and not well known by many users. It has therefore been decided to reconstruct the scripting system using a single scripting language. It is proposed to use Python for this, as it is a well-known language with many relevant tools available as open source, but some concerns about the use of Python still need to be addressed. Users from ALADIN have requested a number of adaptations to facilitate use of the scripting system in their environments. There have been persistent requests from NWP forecast model developers to make a setup of the script system allowing easier research experimentation with the forecast model, without being bothered by the overhead needed for running the model in an operational context. Climate modelers have asked for several adaptations which will make it easier for them to perform long climate runs. It will be seen how these requests can be accommodated in the revamped scripting system. Finally, the rewrite of the scripting system offers a good opportunity to clean up and better document the system.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SY3.1	Revise script system to a single scripting language	DaSa, MaKa	Non t-code
SY3.2	Adapt script system (together with ALADIN partners) to accommodate stated ALADIN wishes	DaSa, MaKa	
SY3.3	Develop and maintain a more user-friendly system setup for forecast model experiments and long climate runs	AnHe	
SY3.4	Prototype generation of “build task” to improve code compilation and as proof of concept.	SaSa	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SY3.1	DaSa	Scripts	2018
SY3.4	DaSa	Scripts	2018

ALADIN/HIRLAM/LACE WorkPackage description : SY4

WP number	Name of WP
SY4	Hirlam maintenance and support
WP main editor	**Daniel Santos**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
NiSo	Niko Sokka	FMI Finland	0.25
ToMo	Toon Moene	KNMI Netherlands	0.25

WP objectives

Maintenance and support of the latest HIRLAM model version.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SY4.1	Maintenance of HIRLAM RCR at FMI and parallel suite at ECMWF	ToMo, NiSo	Non t-code
SY4.2	Maintenance of HIRLAM, including bug fixes and necessary adaptations to accommodate changes of ECMWF computational platform and boundary data	ToMo, NiSo	Non t-code
SY4.3	Technical assistance for operational activities using Hirlam system.	ToMo, NiSo	Non t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : HR1

WP number	**Name of WP**
HR1	(Sub)-km configurations and turbulence R&D activity
WP main editor	**Sander Tijm & Martina Tudor & Petra Smolikova & Claude Fischer**

Table of participants

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth or External project**
AE	AEMET team	AEMET Spain	4
JuCe	Jure Cedilnik	ARSO Slovenia	2
PeSm	Petra Smolíková	CHMI Czech	1
MaHr, MaTu	Mario Hrastinski, Martina Tudor (2, 2)	DHMZ Croatia	4
XiYa	Xiaohua Yang	DMI Denmark	1.5
BoBo, JaWo, PiSe	Bogdan Bochenek, Jadwiga Woyciechowska, Piotr Sekula (1, 1, 1)	IMGW Poland	3
JaWi	Jason Williams	KNMI Netherlands	5
MaNa	Marass Najla	Maroc Meteo	0.75
CoCl, EmGl	Colm Clancy, Emily Gleeson (4, 3)	MET Eireann	7
RaHo	Rachel Honnert : CNRM/GMAP	Météo-France	5
DiRi	Didier Ricard : CNRM/GMME	Météo-France	11
ViHo, DaLa	Viktoria Homonnai, David Lancz (3, 6)	OMSZ Hungary	9
EsOl	Esbjorn Olsson	SMHI Sweden	2.5
PiSi	Pier Siebesma	University of Delft	ext
PhSc	Phillip Scheffknecht	ZAMG Austria	3

WP objectives

This work package sheet describes the intended efforts at the HIRLAM and ALADIN consortia towards research versions of (sub)-km AROME-France, HARMONIE-AROME and ALARO. These experiments require high resolution input data on physiography. In addition to this, HIRLAM will also consider options for data assimilation settings, ensemble configurations, and computational efficiency aspects. Furthermore they will study the optimal configuration for an operational resolution increase of the present 2.5km (ensemble) operational configurations, considering the best balance between aspects like horizontal and vertical resolution, domain size and ensemble configuration. These experiments will be done on several (maritime and continental) testbed domains.
Aspects to be studied are the numerical stability, particularly near steep topography; the meteorological and computational effects of using higher order than linear spectral grids; the possible need to tune physics parameterizations, the settings of horizontal and numerical diffusion; and the provision of adequate physiography data.
The model will be run in LES mode at resolutions down to tens of meters over areas where orographic data of sufficient resolution are available. The results should show if there are limitations in the spectral technique at such resolutions, for example at or near steep slopes. Simulations of different weather situations are needed in order to study the interactions between resolved and parametrized processes related to convection, turbulence, waves, radiation and microphysics.
Currently, in ALARO, operational dynamical adaptation of wind to high resolution topography uses rather old set-up and cycle. The aim is to find an optimum set-up of dynamics and turbulence (TOUCANS) scheme and to test the method for a range of resolutions in order to explore its limitations.
At Météo-France, while no plans for an operational implementation exist in a foreseeable future, the aim is to start R&D efforts for AROME-France at 500m mesh size, and evaluate the implementation of a test configuration for a possible field campaign in the vicinity of a French airport.
The research and development will also include work on horizontal and vertical diffusion (turbulence) on sub-km scales. The horizontal diffusion will be re-designed and tuned depending on the scale aimed to in the high resolution experiments.These scales approach the grey-zone of shallow convection and turbulence. The computation of the SLHD diffusion coefficient will be modified to become a function of the total flow deformation.
The relation between the horizontal diffusion applied by the model dynamics (SLHD or conventional spectral horizontal diffusion) and the parameterized vertical diffusion will be studied for a range of resolutions.
At present, physics parameterizations treat the model grid as a series of independent vertical columns. Future models are likely to require (quasi-)3D parametrizations for several processes which are partially resolved on those scales. Such approach is being tested in turbulence and radiation schemes. The physics-dynamics interface may need to be adapted to permit this.

Descriptions of tasks

Task	**Description**	**Participant abbrev.**	**Type of deliverable**
HR1.1	Nest and run an LES model within Harmonie-Arome for the determination of improvements towards small scale variability	JaWi	report
HR1.2	Introduction of several sub-km local domains, configuration experiments with high-resolution Harmonie-Arome to establish the best balance in an operational upgrade, experiments with data-assimilation cycling	XiYa, EsOl, BoBo, PiSi, AE	report
HR1.3	Experiments at sub-km resolutions. Test various horizontal/vertical resolutions using high-resolution surface elevation data (SRTM). Compare Harmonie-Arome at various hectometric resolutions against LES.	JuCe, BoBo, JaWi, PhSc, AE	report
HR1.4	Numerical methods on the km- and hectometric scale: study the limitations of the spectral approach and, possibly, the semi-Lagrangian scheme. Test limitations of the semi-implicit time-stepping for use at hectometric resolutions.	CoCl, AE	report
HR1.5	Consider the best way to introduce stochasticity at very high resolutions (related to PH2, E2)	tbd	t-code, configuration
HR1.6	An update of the AROME-France 500m configuration and its assessment during a field campaign in order to improve forecast of hazardous weather events near airports.	GMAP staff, MaNa	namelists

HR1.7	Establish a model setup that would run dynamical adaptation of wind using the latest export version and establish optimal tuning of dynamics and TOUCANS.	MaTu, MaHr	report, scripts, namelists, t-code ?
HR1.8	Consider the role of horizontal diffusion and SLHD, investigations of computational efficiency and possible ways to improve it (e.g. test single vs double resolution)	CoCl, EGI	configuration
HR1.9	Investigate shallow convection and turbulence behaviour in Harmonie-Arome at hectometric scales. Perform literature study on 3D effects of turbulence. Is 1D+2D enough ?	tbd	report
HR1.10	PhD: study the turbulence grey zone where eddies are partly solved.	DaLa, RaHo	report, doc, paper
HR1.11	3D turbulence solution in the AROME/ARPEGE/IFS code structure: how to implement 3D effects including horizontal exchange.	RaHo	report, t-code
HR1.12	Assess the role of horizontal mixing and gradients in 3D turbulence, at the level of processes, using Méso-NH. Liaison with the 3D-turbulence activity in AROME.	DiRi	report, non-t-code
HR1.13	Redesign of the diffusion coefficient used in SLHD and being a monotonic function of the total flow deformation along the terrain-following vertical levels.	ViHo, PeSi	report, non-t-code
HR1.14	Study of the resolved versus sub-grid turbulent kinetic energy spectra in high resolution runs of ALARO, aiming to redesign the horizontal/vertical diffusion treatment.	ViHo, PeSi	report, non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
HR1.5	tbd		end 2018
HR1.7	MaTu		end 2018
HR1.11	RaHo		end 2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
H1.1	PeSi	report	
H1.2	XY, EO	report	
H1.3	tbd	report	
H1.4	CoCl, JS	report	
H1.5	tbd	namelist, configuration	
H1.6	GMAP staff	namelists	
H1.7	MaTu	report, namelist, scripts	
H1.8		configuration	
H1.9	tbd	report	
H1.10	DaLa	report, doc, paper	
H1.11	RaHo	report, non-t-code	
H1.12	DiRi	report, non-t-code	
H1.13	ViHo	report, non-t-code	end 2018
H1.14	ViHo	report, non-t-code	end 2018