ALADIN/HIRLAM/LACE
Rolling Work Plan 2020

Adopted by the ALADIN General Assembly and HIRLAM Council

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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.

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 2020. 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 and engineering, 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 consortia.
- A limited number of strategic (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 strategic 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 programs may be introduced.
- Prospective 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 parameterizations, surface analysis and modeling, ensemble forecasting, very high resolution modeling, quality assurance and technical code and system development. 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 MGMT1: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 COM3.1: Support for maintenance and Partners' implementations of the ALADIN-HIRLAM System in the ALADIN countries. These activities focus mostly on the ALADIN Coordination and Networking activities.

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

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 MGMT3: Coordination activities by the HIRLAM Management Group
- 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 pre-phasing testing, phasing activities, and forward phasing of new Harmonie code contributions to the latest T-cycle; 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; 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 chapter 4.

1.1.3 General description of the LACE work

The planned LACE activities on development of the ALADIN-LACE-HIRLAM system focus on various aspects of the model dynamics, physics (including surface aspects), data assimilation (including surface data assimilation) and ensemble forecasting. The LACE working plan is integrated in the this

ALADIN/HIRLAM/LACE RWP, and described in different WPs. Those contributions are mainly prepared by LACE area leaders on physics, dynamics, data assimilation and ensemble forecasting. The work of LACE programme manager, data manager and system manager are also presented in the RWP. The following Work Packages are focused on the LACE work:

- WP MGMT2: LACE Management
- WP COM2: The activities related to preparation of code contributions to the now cycles and phasing, preparing the CMC releases (in particular the ALARO CMC), preparing documentation, phasing activities, backphasing some of the developments related to ALARO CMC and forward phasing of the new developments related to ALARO.
- WP COM3.1 The activities sud as support and coordination of activities leading to implementation of new code version at the LACE and other ALADIN Members' NMSs and collecting the reported problems and their solutions and assisting preparation of code bugfixes, including a coordination of operational changes between MF and LACE Partners.
- WP COM 3.3 LACE supports the activities related to trainings by supplying teachers, organizing trainings in Member services and supporting students.

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. An overview of the expected consequences of the research and development tactivities 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 and difficulties, organization and staffing).

The content and timing of a new code release depend on the nature of that release. The content of tLAM 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 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 fall 2019.

T-cycles receive R&D contributions from both ALADIN and HIRLAM and can be technically evaluated mostly by sanity checks (so-called "mitraillette" 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. Each CMC is technically evaluated for a reference provided in mitraillette.

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 wishes to further evaluate at consortium-level a number of national domains, 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. It is not foreseen in this MoU-phase to push the common maintenance activity down to the level of common (pre-)operational evaluation. The latter evaluation is left to the activity of member NMS teams or sub-groups willing to start a common activity there. In order to aid the member teams in local pre-operational evaluation, export versions (and bug fixes) are accompanied by a documented namelist, description of choices and recommendations (this is already done at least for the ALARO CMC). Recent scientific and technical developments are explained in documentation, ALADIN-HIRLAM Newsletters and at regular Consortium workshops.

The thematic work package sheets in chapter 4 provide an overview of the R&D developments and the resulting code implementations at a time scale of about 2-3 years. A detailed list of expected new code 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 here. For the forecast model CMC’s, several R&D tasks in the dynamics will provide new possibilities for the code of the dynamical kernel: handling of vertical velocity (w) in the gridpoint dynamics computations, research on alternative gridpoint solvers for the SISL scheme. The two-moment microphysics scheme LIMA is now 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 significant changes (both new developments and activation of new options) in the surface model and analysis code, the introduction of flow-dependent data assimilation (4D-Var plus optionally several ensemble assimilation setups and nowcasting tools), innovations in the treatment of aerosol and in the turbulence, cloud, microphysics and radiation schemes, and in the ensemble perturbation codes..

The perhaps most prominent evolution of the atmospheric data assimilation code will be the almost finished re-factoring of the FORTRAN codes for use in OOPS. This completion, while being purely technical, 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 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, Aeolus, scatterometers 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 (AMDAR, Mode-S and 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 and 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.

Météo-France devotes between 5 and 7 FTE to phasing efforts per year and this figure is likely to increase to about 8-9 FTE in the next two years because of the OOPS efforts. Staff from the consortia (ALADIN and LACE) are invited to Météo-France and provide about 1 FTE of additional manpower for this sometimes tedious code phasing. HIRLAM staff (mostly system experts) spend a comparable amount of efforts on (pre- and forward) phasing, only mostly off-site, under the coordination of a designated cycle master. For the future, the possibility to increase the efforts of preparatory technical work, feasible in a decentralized manner (at partner NMS's), 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* refers to sharing a common labeling of master and remote trunks, rather than to a physically co-located repository. Moreover, trends towards more automated testing of individual development branches, more progressive step-wise code implementations, systematic testing of components of DA, will all be explored. These investigations will involve using the new facilities provided by the OOPS framework, and specific dedicated tools like Python-scripting or GIT-tools. 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 code 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.

In addition to the main NWP shared codes of the IFS-ARPEGE-LAM "galaxy", the CMCs require specific specialized codes whose technical evolution is taking place in a dedicated community. LAM partners then are one component of this community, which has its own governance and standards. One such example of "external" code is SURFEX. This code is developed by the SURFEX community and maintained in a 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. HIRLAM is presently experimenting with a SURFEX NWP branch as a platform to port new developments from the Harmonie surface code into SURFEX and vice-versa.

2. Strategic (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 strategic 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 members that 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 in their operational suites, including the handling of a (limited) set of observations, 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 following activities are being carried out within this programme:

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 (started in 2018)
4. Set up a basic cycling system (started 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 (started in 2018)
6. implement and assess the basic data assimilation configuration locally (2019 and later).

3. Prospective 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 Météo-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. A more integrated system for ensemble forecasting (3- or 4D-EnVar) is under development, as this appears to offer a higher quality at significantly lower computational cost and better scalability. Météo-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 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 INCA, 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. SAPP) and the developments on observations diagnostics and monitoring tools including OPLACE.

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 parameterizations

The key difference between the three present canonical model configurations Arome-France, Harmonie-Arome and Alaro, lies in the choices for the physics parameterizations. 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. A new WP PH5 has been included, with the aim to identify model post-processing output that are relevant to add to the common code, and make plans and preparations for developing and implementing such new common post-processing.

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 LAEF (WP E4) system. The operations of the GLAMEPS system (formerly WP E5) have ceased in mid-2019, therefore this WP has been discontinued in RWP2020.
- 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)
- HIRLAM-only: 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)
- HIRLAM-only: the revision of the Harmonie scripting system (WP SY3)

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: Timeline of future cycles

Joint cycle	ECMWF	MF	Start of phasing	Declaration	Misc. / Oper plans
CY46			Start Jan 15th, 2018	10 April 2018	*OOPS aspects added as extra branch on CY45R1 for CY46*
		CY46T1	October 2018	28 February 2019	Technical update for fixes (assimilation) plus some science
		CY46T1_bf	*June 2019*	*September 2019*	*This is a specific branch for wrapping up CY43T2_op2 changes on top of CY46, as a step towards CY47T1*
	CY46R1		31 May 2018	Feb 2019	OOPS updates + science. Operational since 11 June 2019
CY47			Mid-February 2019	July or Aug 2019	Target joint cycle for baseline OOPS in Research mode
		CY47T0	*End August 2019*	*September 2019*	*OOPS-MF prototype & array bound check*
		CY47T1	By about 10 October 2019	End of November 2019	Deadline of contribution will not be “expandable”. MF aim is to wrap-up all changes from CY43T2_op2. LAM partners will be asked to follow the same restricted specs for their contributions.
	CY47R1		July 2019	End of October 2019	Expected to become the porting cycle for Bologna
CY48			Dec 2019	End of Feb 2020	
		CY48T1	Sept 2020 ?	Nov 2020 ?	
	CY48R1		Q2/2020 ?	Q3/2020 ?	Single precision runs in ENS
CY49			Dec 2020	End of Feb 2021	tbc
		CY49T1			
	CY49R1				OOPS operational for 4D-VAR/IFS

ref.: IFS/Arpège coordination videoconference meeting of 4July 2019
(see the Minutes, with Partners only access)

Annex 2: Common cycles and preliminary content

(status of this list as of 27 Sept. 2019)

CY46T1_main has been complemented by wrap-ups from the late source code changes from the CY43T2 e-suite (CY43T2_op1/op2 version from November 2018 onwards), including fixes for GRIB2 or new model output diagnostics (visibility, types of precipitation at ground etc.). This increased version has been tagged as **CY46T1_bf** in MF's GIT. CY46T1_bf.02 is the almost completed version with respect to the wrap-up of MF's CY43T2_op2, and was declared on 9 July 2019.
Validation of data assimilation (Arpège 4D-VAR, Arome 3D-VAR) is ongoing based on this CY46T1_bf.
CY46T1_bf could be considered for an export version (to be confirmed yet).

CY47: the main build process took place over March-May 2019. CY47_main was declared on 19 August 2019. MF has run the mitraillette validation tool on that version, and EC has technically run an IFS 4D-VAR suite.
Content:

OOPS re-factoring in IFS FORTRAN codes:
- VarBC works
- final work for Full-POS as PostProcessor object (MF/REK)
- other required fixes in order to run OOPS-IFS in a full PrepIFS experiment (CY46R1). Note: recent code adaptations in order to run screening in OOPS-IFS are still missing in CY47, and will enter CY47R1.

Scientific contents of CY46R1 and CY46T1

CY47T0: this is a technical quick cycle built in the end of August 2019. The goal was to enable the first early prototypes of tests based on the "davaï" concept and tools (for technical validation). Another goal was to enable to run the Fortran binary executable files using array bound check options throughout the code (this actually required a number of corrections and adaptations of interfaces, following a proposal made by Ryad).
Content:

code changes enabling array bound check options throughout the code, for a number of Arpège and LAM configurations (R. El Khatib)
Fortran/C++ interface codes adapted in order to enable OOPS unitary tests in the "davaï" framework for CY47 (E. Arbogast with A. Mary)
bator change to enable the use of "one obs out of two" (useful for creating smaller obs databases for testing) (F. Guillaume following an idea by F. Suzat)
miscellaneous other bug-fixes found in CY47_main or reported from earlier cycles, <u>excluding</u> those linked with reporting codes from CY43T2 (this is planned for CY47T1)

Declaration of CY47T0_main occurred on 3 September 2019.

CY47T1: October-November 2019. The timing of CY47T1 is very constrained, as MF and EC will start building CY48 as early as December 2019. Contributions to CY47T1 will have to be prepared for Tue 8 October.
Provisional content: because of the timing constraints, delayed contributions will be avoided. Contributions edited in *italic* mode are pending a firm confirmation and commitment by the contributors (meaning here "to be confirmed by the time of the deadline")

System operational aspects (Météo-France o/e-suites):

◦ <u>wrap-up of MF's e-suites based on **CY43T2_op1/op2** and **CY46T1_bf**</u> (all GMAP staff) => finishing this wrap-up into the official trunk is a major goal of this cycle for GMAP

System technical aspects:

◦ *direct reading of NetCDF file formats in c931 and c932 (J.-M. Piriou)*
◦ *inclusion of new configuration c933 aimed to replace c931 and c932 in some near future (A. Napoly, J.-M. Piriou)*

Model algorithmic diagnostics:

◦

Full-POS & Model output diagnostics:

◦ *precipitation types; various flavours of snow cover height (I. Etchevers)*
◦ *for aeronautics: pressure and flight level height of Tropopause and jet (O. Jaron)*
◦ *new fields in Fullpos (CHMI & J. Cedilnik):*
  ▪ *convective temperature,*
  ▪ *mean radiant temperature (needed for evaluating thermal comfort),*
  ▪ *global normal irradiance (for energy producers),*
  ▪ *lightning diagnostics*
  ▪ *vertical temperature gradient (aviation application)*
  ▪ *MLCAPE*
  ▪ *storm motion vector, storm relative helicity, vertical wind shear diagnostics*

Arpège and Arome model dynamics:

◦

Arpège atmospheric physics:

◦ *updated interface to the IFS radiation scheme ECRAD (Y. Bouteloup, following work by M. Raouindi)*
◦ *for Arpège-Climat: additional dry adjustment term; changes in the Lopez microphysics (R. Roehrig, A. Alias)*

Arome atmospheric physics:

◦

SURFEX codes in NWP repository:

◦

Surface analysis & CANARI:

◦ *snow analysis code (C. Birman)*

Assimilation methods:

◦ fixes for trajectory handling in AEARO, for I/O of control vector initial condition slices (Y. Michel)
◦ *re-factoring of some control vector attributes, that are moved from the CV-level down to the levels of slices. Eg. YDCV%ljbwavelet => YDCV%initcv%ljbwavelet, YDCV%lam1d => YDCV%initcv%lam1d (Y. Michel). This will enable more flexibility in defining the spectral space components at slice-level. Pending a decision in liaison with ECMWF.*
◦

Observations:

◦ *GNSS ZTD horizontal gradients observation operator (P.Moll) tbc*
◦ *AMDAR humidity data: optimize QC and assimilation in ALARO or AROME 3D-VAR (P. Moll, A. Trojakova, F. Meier)*
◦ *final (and agreed) code for handling Mode-S data in the Arpège and LAM systems (V. Pourret, coordination MF-KNMI team)*

ALADIN:

◦ Graupel code: required a deeper restructuring (with respect to what's coded in CY45T1). In CY45T1, (IF LGRAPRO) statements were commented out in four subroutines in order to compile the codes with Intel. The debugged version of the graupel code is expected to enter in CY47T1 (B. Bochenek & J. Masek)

- Miscellaneous ALARO physics aspects (J. Masek – 10 Sept. 2019):
  - DDH budgets for prognostic TKE and TTE (in TOUCANS) added by Mario Hrastinski.
  - New cloudiness treatment in vertical diffusion by Radmila (introducing new options NDIFFNEB=4 and 5).
  - Fixes in adjustment and microphysics by Luc Gerard. These will be deactivated by local key, since they require more extensive validation.
  - TOMS (3rd order moments in TOUCANS) fixes by Peter Smerkol. These will be deactivated by local key as well.
  - Further modularization and optimization of ACRANEB2. Exact content depends on how much will I (Jan) manage to implement until deadline.
  - Fixes of blend utility (new FA date structure, split of ECHIEN to ERIEN, reintroduction of Z_NSIGN, making official version working). Today I (Jan) found that blend utility in cy47t0 is crashing, the problem might be related to xrd adaptation for single/double precision. I am trying to make it working again.
- Dynamics:
  - *implementation of the variables d5/W5 proposed by Fabrice Voitus (J. Vivoda, P. Smolikova in collaboration with Karim and Fabrice)*

HIRLAM: to be confirmed (under discussion – likely that not all what's listed below will enter CY47T1)

- *Harmonie-Arome related physics:*
  - *MUSC LFA: write model level data*
  - *microphysics changes (and interface to radiation) (T. Moene, K.-I. Ivarsson, W. de Rooy)*
  - *fixes for clouds – turb – convection (U. Andrae)*
- *Assimilation aspects:*
  - *Bator changes for Ps/Pmsl from Synop & Buoy*
  - *Harmonie-Arome blacklist versions*
  - *Brand; hybrid EnVar*
- *surface perturbation for EPS in pertsfc.F90*
- *EPS aspects:*
  - *infrastructure for Harmonie-Arome SPP (based on IFS codes extended) (U. Andrae, I.-L. Frogner)*
  - *implement SPG based on Tsyrulnikov etal. (U. Andrae)*
- *Technical changes: initialization, OpenMP, fixes etc.*

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*

The declaration of CY47T1 is expected by the end of November.

CY48: December 2019 – end of February 2020. The timing is constrained by MF's change of HPC, which will occur in spring 2020. Porting the operational NWP suites to the new (BULL-Sequana) HPC will take place from March onwards.

Provisional content:

OOPS re-factoring in IFS FORTRAN codes:

- adapted handling of time and time step variables for multiple MODEL instantiation - Step 2
- VarBC tidy-up for OOPS-IFS, C-VarBC
- VarQC, observation error correlations (already in CY47)
- finalized OOPS/Fortran interfaces to run Screening and Continuous Data Assimilation with OOPS/IFS
- any required fix in order to run OOPS-IFS in a full PrepIFS experiment (CY47R1)
- fixes for OOPS/Arpège or OOPS/Arome

scientific and technical contents of CY47R1 and CY47T1

Declaration of CY48 is expected by the end of February 2020.

CY48T1: provisional timing is autumn 2020.

Hypothetical content:

System operational aspects (Météo-France o/e-suites):

-

System technical aspects:

-

Model algorithmic diagnostics:

- *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)*
- *new version of "W-term" for NH-EE (NVDVAR=14) (F. Voitus)*
- *mass correction option from Arpège-Climat adapted to Arpège-NWP for the new cycles (CY47 and beyond, with the model objects) (H. Petithomme)*

Full-POS & Model output diagnostics:

-

Arpège and Arome model dynamics:

- *various dynamics updates and cleaning (F. Voitus):*
  - *NH-QE treatment of w improved*
  - *simplification of the spectral SI operator generalized to H and NH, global and LAM*
  - *modified handling of bottom boundary condition for w: implement a modified W following the condition W_mod = 0 (proposal by L. Auger)*
  - *more proper use of R_dry (versus R_moist) in dynamics*
- *3D grid point solver for SI hydrostatic model (research version) (L. Auger)*

Arpège atmospheric physics:

- *evolution of Lopez microphysics (Y. Bouteloup)*
- *interface to the IFS deep convection scheme (Y. Bouteloup)*
- *computation of the TKE production term from deep convection (Y. Bouteloup)*
- *rewrite of PCMT code in order to make the Météo-France NWP and Arpège-climate versions converge (J.-M. Piriou, J.-F. Guérémy)*
- *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)*
-

Arome atmospheric 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*

SURFEX codes in NWP repository:

- *implement Surfex official code release v8.x or even v9 (Y. Seity)*

Surface analysis & CANARI:

- *snow analysis code (C. Birman)*

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*
- *AMDAR humidity data: optimize QC and assimilation in ALARO or AROME 3D-VAR (P. Moll, A. Trojakova, F. Meier)*
- *final (and agreed) code for handling Mode-S data in the Arpège and LAM systems (V. Pourret, coordination MF-KNMI team)*

ALADIN:

- ALARO physics:
  -
- Dynamics:
  - *implementation of the variables d5/W5 proposed by Fabrice Voitus (J. Vivoda, P. Smolikova in collaboration with Karim and Fabrice)*

HIRLAM:

-

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.)*
- *FORTRAN and interface codes for EnVar solutions as developed for ARPEGE and AROME*
- *adaptation of LAM MODEL components, possibly DDH code, to OOPS (A. Mary)*
- *remove the Tomas' trick for YOMPHY* variables. Proper handling of the MODEL parameters inside calls to MF obs operators (A. Mary & OBS team ?)*

Annex 3: Work packages and staff resources for 2020

Work package	Description	Resources (pm) ALADIN[1]	Resources (pm) HIRLAM	See page
MGMT1	Management and ALADIN support activities	46	0	*19*
MGMT2	Management LACE	20	0	*20*
MGMT3	Management HIRLAM	0	28.75	*21*
COM1.1	ALADIN Code architect coordination activities	2	0	*22*
COM1.2	HIRLAM Code analyst activities	0	0	*23*
COM2	Code generation and maintenance	120	16	*24*
COM3.1	Maintenance and Partners' implementations of ALADIN system	72	0	*26*
COM3.2	Support for maintenance and implementation of Harmonie system on local machines	0	1	*27*
COM3.3	Training (preparation, lectures, attendance)	2	0	*28*
SPDY1	More stable Formulations : Quasi-Elastic (QE) system, new vertical coordinate	4	0	*29*
SPDY2	Development of methods for solving the implicit equation in gridpoint space.	27.5	0	*30*
SPDY3	Horizontally Explicit Vertically Implicit (HEVI) methods with ALADIN-NH core	0.5	0	*31*
SPDY4	Physics-dynamics interface	2.5	0	*32*
SPDY5	Development of LAM components in Atlas	3	4	*33*
SPDA1	Basic data assimilation setup	38	0	*34*
DA1	Further development of 3D-Var (alg. Settings)	26	9	*36*
DA2	Development of flow-dependent algorithms	57.5	19.25	*38*
DA3	Use of existing observations	94.75	43.75	*40*
DA4	Use of new observations types	72	12	*42*
DA5	Development of assimilation setups suited for nowcasting	24.25	17	*44*
DA6	Participation in OOPS	25.5	1	*46*
DA7	Observation pre-processing and diagnostic tools	12	11	*47*
DY1	Boundary conditions and nesting	1.5	0	*49*
DY2	Time-stepping algorithm	6	0	*50*
DY3	Vertical discretization	6	0	*51*
DY4	Semi-Lagrangian advection	0.5	0	*52*
PH1	Developments of AROME-France (and ARPEGE) physics	55.5	0	*53*
PH2	Developments of HARMONIE-AROME physics	0	28.75	*54*
PH3	Developments of ALARO physics	42	0	*56*
PH4	Common 1D MUSC framework for parametrization validation	8.5	2.25	*57*
PH5	Model Output Postprocessing Parameters	30.5	1	*58*
SU1	Algorithms for surface assimilation	15.75	9.5	*59*
SU2	Use of observations in surface assimilation	26.5	8.75	*61*
SU3	SURFEX: validation of existing options for NWP	54	16.75	*63*
SU4	SURFEX: development of model components	8.25	6.75	*65*
SU5	Assess/improve quality of surface characterization	10	11	*66*
SU6	Coupling with sea surface/ocean	3	0	*68*
E1	Arome-France EPS (PEARO)	74	0	*70*

1 1 Full Time Equivalent : 1 FTE/year = 11 person.month per year

E2.1	Development of convection-permitting ensembles: HarmonEPS - Physics perturbations	7	17.25	*71*
E2.2	Development of convection-permitting ensembles: HarmonEPS - Initial conditions perturbations	0	4	*72*
E2.3	Development of convection-permitting ensembles: HarmonEPS - Surface perturbations	1	13.5	*73*
E2.4	Development of convection-permitting ensembles: HarmonEPS - Lateral boundary perturbations	0	1.5	*74*
E2.5	Development of convection-permitting ensembles: HarmonEPS - HarmonEPS system	0	3	*75*
E3	Development, maintenance and operation of convection-permitting ensembles for LACE	20.5	0	*76*
E4	Development, maintenance and operation of LAEF	16	0	*77*
E6	Ensemble calibration	0	6	*78*
QA1	Development of HARP	3	2.25	*79*
QA2	Development of new verification methods	7	14.5	*81*
QA3	Quality assessment of new cycles and alleviation of model weaknesses	18	17	*83*
SY1	Code optimization	6	6.25	*85*
SY2	Maintenance and development of the Harmonie Reference System	0	14	*87*
SY3	Revision of the Harmonie scripting system	0.5	11.5	*88*
HR1	(Sub)-km configurations and turbulence R&D activity	30	9.5	*89*

ALADIN/HIRLAM/LACE WorkPackage description : MGMT1

WP number	Name of WP
MNGT1	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	18
WK/ASM	Local organisers : Neva Pristov (1) and other team	ARSO Slovenia	2
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, WK/ASM	
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
MNGT2	Management LACE
WP main editor	**Martina Tudor**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MaTu	Martina Tudor	DHMZ Croatia	11
MaBe	Martin Bellus	SHMU Slovakia	2
OlSp	Oldrich Spaniel	SHMU Slovakia	1
JuCe, BeSt	Jure Cedilnik, Benedikt Strajnar	ARSO Slovenia	3.5
PeSm, AlTr	Petra Smolikova, Alena Trojáková	CHMI Czech	2.5

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	MaTu	
MGMT 2.2	Actitivties on LACE related meetings, such LSC, council meeting and managem	All	
MGMT 2.3	Preparation, monitoring and execution of LACE work plan	All	
MGMT 2.4	Reporting to LACE council	MaTu	
MGMT 2.5	Preparation and execution of the annual budget	MaTu	
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 : MGMT3

WP number	**Name of WP**
MNGT3	Management HIRLAM
WP main editor	**Jeanette Onvlee**

Table of participants

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth or External project**
JeOn	Jeanette Onvlee	KNMI Netherlands	11
DaSa	Daniel Santos	AEMET Spain	2
PaSa	Patrick Samuelsson	SMHI Sweden	3
RoRa	Roger Randriamampianina	Met Norway	4
InFr	Inger-Lise Frogner	Met Norway	4
SaTi	Sander Tijm	KNMI Netherlands	2
FrLa	Frank Lantsheer	KNMI Netherlands	2.75

WP objectives

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

Descriptions of tasks

Task	**Description**	**Participant abbrev.**	**Type of deliverable**
MGMT 3.1	Coordinate the work of the HIRLAM management group and of the core group members. Coordinate research, development, validation and maintenance activities with relevant ALADIN partners.Reporting on the progress in the programme to HAC and HIRLAM Council. Strategic discussions with HAC and Council, execute strategic decisions made by HIRLAM Council.	All	coordination and preparation of scientific plans and strategy
MGMT 3.2	Prepare a rolling work plan in collaboration with ALADIN partners. Report on the progress of the RWP to HAC and HIRLAM Council	All	RWP submitted yearly to HAC and Council
MGMT 3.3	Prepare and execute a yearly staff and financial budget for examination by the HAC and approval by HIRLAM Council. Keep an account on the realization of these budgets and report on this to HAC and HIRLAM Council.	JeOn	Staff and financial budgets and realization yearly submitted to HAC and Council
MGMT 3.4	Ensure that at any time a Harmonie Canonical Model Configuration and Reference System are defined and available for operational implementation, and supervise the evolution of this CMC and Reference System.	DaSa	Bringing out new Reference releases and associated change record and documentation.
MGMT 3.5	Coordinate the regular maintenance of scientific and technical documentation and of the HIRLAM web site.	DaSa, FrLa	https://hirlam.org/trac/wiki, hirlam.org
MGMT 3.6	Organize and coordinate ASM/Workshops, HMG and HMG-CSSI meetings, working weeks and joint meetings with ALADIN.	All	meetings and workshops
MGMT 3.7	Prepare and publish a joint ALADIN-HIRLAM Newsletter	FrLa, JeOn	2 newsletters/year

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 SPDY,DA6, PH4)	RMI Belgium	2

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	

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
COM1.2.1	Attend technical meetings between ECMWF, MeteoFrance, Hirlam and Aladin.	RoSt	(meetings)
COM1.2.2	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
COM1.2.3	(Help) develop and promote the use of block unit tests for the LAM data assimilation components (see DA6.3)	RoSt	Tests, code for mitraillette
COM1.2.4	Propose technical solutions to implement LAM data assimilation algorithmic components and developments within the IFS/OOPS framework	RoSt	document
COM1.2.5	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
COM1.2.3	RoSt	CY47T?	End 2019?

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM1.2.2	RoSt	document	End 2019
COM1.2.4	RoSt	document	End 2019
COM1.2.5	RoSt	documents, presenta	2019

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, HaPe, REK, PaSa, FlSu, MFSci	GCO team, C. Fischer, A. Mary, H. Petithomme, R. El Khatib, P. Saez, F. Suzat, Météo-France scientific code experts as requested	Météo-France	108
ACNA, CA	ACNA and Code Architect (alreay included in other WPs)		
ASCS	Oldrich Spaniel - LACE ASC	SHMU Slovakia	4
PHAS	ALADIN phasers in Toulouse (Note: the total amount of ALADIN phasing staff is evaluated to about 1 FTE per year)	ALADIN (other than MF, Poland, Algeria)	4
PHAS	B. Bochenek (1), P. Sekula (1)	IMGW Poland	2
PHAS	Algerian team	ONM Algeria	2
DaSa,UlAn, ToMo,EoWh, DASci, PhySci	Daniel Santos(2), Ulf Andrae(2), Toon Moene (3), Eoin Whelan(3), DA Scientists(3), Phy Scientists (3) (The PMs for DASci and PhySci are reflected on DA2, DA5 and PHY2 WPs)	HIRLAM	16

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 by the ECMWF/Météo-France coordination meetings. Note that the LAM mitraillette tests are being evaluated in these joint cycles, i.e. the LAM CMCs should ideally work with these releases.	GCO, ClFi, AlMa, HaPe, REK, PaSa, MFSci, PHAS, ASCS	t-code (complete)
COM2-2	Build of a T-cycle ARPEGE/LAM version, common to ALADIN and HIRLAM. These are the cycles that will contain scientific and technical changes from the LAM groups (and from MF for ARPEGE).	GCO, ClFi, AlMa, HaPe, REK, PaSa, MFSci, PHAS, ASCS, SAL, SET, DACA	t-code (complete)
COM2-3	Cross-coordination aspects for planning timing and content of T-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 tool	HaPe, PaSa, AlMa, ClFi, CA	non-t-code
COM2-5	Generation of Harmonie-Arome CMC code version from the latest MF T version available. Technical testing (running testbed daily at ECMWF), and upward phasing of new code to the latest available cycle. Communication with (not only) NMHS about the progress of local installations of this code, encountered problems and their solution and reporting this to other HIRLAM/ALADIN members.	DaSa,UlAn	non-t-code
COM2-6	Communication with Meteo-France about the content and the schedule of new T version. Collection and documentation of available fixes; reporting on the progress whenever relevant. Close collaboration with ALADIN and RC LACE ASC and MF contact point is an essential part of the activity.	SAL	non-t-code (report)
COM2-7	Maintenance and specific tidying-up of the codes that are being used for computing the PGD/climatological files	FlSu, AlMa, ClFi	t-code & scripts
COM 2-8	Implementation, monitoring, pre-release validation and testing, release and maintenance Harmonie-Arome CMC; support of the Harmonie-Arome CMC at one or more operational platforms.	DaSa, UlAn	Non-t-code
COM 2-9	Continue the developments and coordination on GIT repository strategies. Improve the Implementation to facilitate cross consortium code evolution collaboration.	DaSa, KaSa	Non-t-code
COM 2-10	Forward phasing of HIRLAM codes to the latest joint cycle. Coordination and enhace HIRLAM scientists colaboration on porting the codes from Harmonie-Arome CMC to the latest cycle available.	DaSa,UlAn, EoWh, WiRo,JaBa	t-code

t-code deliverables

Task	Responsible	Cycle	Time
COM2-1	ClFi	refer to timing of cycles	CY47 to be declared by June 2019; CY48 planned for Feb-March 2020 (tbc)

COM2-2	ClFi	refer to timing of cycles	build CY47T1 (autumn 2019 tbc). NOTE: no timing yet for CY48T1
COM2-7	ClFi	refer to timing of cycles	the scripts work with CY43T2 in 2019 - possibly with CY46T1_bf in 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM2-3	ClFi, ACNA, SAL	documentation, communication	2/year @LTM meeting & @IFS-Arpège coordination meetings
COM2-4	AlMa, HaPe, ClFi	scripts, data	
COM2-5	DaSa	h-code	2019
COM2-6	DaSa	documentation, communication	2019
COM2-8	DaSa	h-code	2019
COM2-9	DaSa	documentation, scripts	2019

ALADIN/HIRLAM/LACE WorkPackage description : COM3.1

WP number	**Name of WP**
COM3.1	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	3
ClFi, AlJo, FrBo	Claude Fischer, Alain Joly, François Bouyssel	Météo-France	1
all	all ALADIN Partners	ALADIN	40
all	Belgium team	RMI Belgium	4
all	Croatian team	DHMZ Croatia	4
all	Slovenian team	ARSO Slovenia	6
all	Austrian team	ZAMG Austria	4
all	Hungarian team	OMSZ Hungary	4
all	Moroccan team	Maroc Meteo	6

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	
COM3.1.5	Operational implementations at ALADIN NMSs	all	
COM3.1.6	Quality assessment of operational suites	all	

t-code deliverables

Task	**Responsible**	**Cycle**	**Time**
COM3.1.2	MaDe (+ HIRLAM PL for system + RC LACE ASC)	CY43T2bfxx_export (if incrementally exported), or CY46 (if exported in 2020)	2020

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 : COM3.2

WP number	Name of WP
COM3.2	Support for maintenance and implementation of Harmonie system on local machines
WP main editor	**Daniel Santos**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
SysTeam	System Team (Daniel Santos, Niko Soka, Ulf Andrae, Eoin Whelan, Bert Van Ulft, Toon Moene, Ole Vignes, Trygve Aspelien, Martynas Kazlauskas, Rymvidas Jasinskas)	HIRLAM	1

WP objectives

The aim of the WP is to support and coordinate the activities leading to implementation of new code version of Harmonie-Arome at the HIRLAM Members; distribute relevant information among HIRLAM Members, 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 HIRLAM Members is needed. Reporting to relevant bodies. Collaboration with MF, ALADIN and RC LACE relevant persons.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
COM 3.2.1	Support on porting Harmonie-Arome CSC configuration to different platforms and ensuring platform equivalence	SysTeam	non t-code
COM 3.2.3	Maintenance and troubleshooting support for Harmonie-Arome by system group (e.g. through forum)	SysTeam	non-t-code
COM 3.2.4	Work on backup and trouble-shooting guidelines to ensure smooth operational running	SysTeam	Non-t-code

T-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM 3.2.1	DaSa	h-code	2019
COM 3.2.2	DaSa	report	2019
COM 3.2.3	EoWh	report, bug fixes	2019
COM 3.2.3	UlAn	bug fixes, scripts and optimizations	2019

ALADIN/HIRLAM/LACE WorkPackage description : COM3.3

WP number	**Name of WP**
COM3.3	Training (preparation, lectures, attendance)
WP main editor	**Jeanette Onvlee, Piet Termonia, Martina Tudor, Claude Fischer**

Table of participants

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth or External project**
ClFi	Claude Fischer	Météo-France	1
GMAP	any volunteering GMAP staff	Météo-France	1

WP objectives

Descriptions of tasks

Task	**Description**	**Participant abbrev.**	**Type of deliverable**
COM3.3.1	Note: Claude regularly gives several hours of introductory tutorials to the code architecture, the link with some basic scientific ideas (eg. SISL spectral, LAM, LBC, DA etc.) and jargon vocabulary of our NWP community. This is done in front of a whiteboard, without specific input material. The audience usually is limited to max. 3 persons, newcomer ALADIN phasers or GMAP "youngsters".	ClFi	ideally, somehow "aware" newcomers in the NWP business.
COM3.3.2	The French NWP Section tries to regularly arrange dedicated 1h tutorials on specific topics of interest, either scientific or technical. These tutorials are called "SistemD". Speech and slides are in French.	GMAP	tutorial
COM3.3.3	Reminder from 2019: "code training days" workshop in Toulouse on 9-12 September 2019.	GMAP	tutorial material

t-code deliverables

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

Non-t-code deliverables

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

ALADIN/HIRLAM/LACE WorkPackage description : SPDY1

WP number	Name of WP
SPDY1	More stable Formulations : Quasi-Elastic (QE) system, new vertical coordinate
WP main editor	**Ludovic Auger, Sander Tijm**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
FaVo	Fabrice Voitus	Météo-France	4

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. Different strategies are currently explored: 1. The use of an alternative class of equation (Arakawa and Konor, 2009) that may be viewed as the minimal modification to the Euler equations (EE) system which allows a filtering of elastic waves. This system can be viewed as an evolution of the anelastic system since the approximation is not made around a stationary and horizontally homogeneous reference-state, but around a more general state close to the hydrostatic state. The current objective is to continue testing that formulation inside our common code. 2.The use of a modified vertical velocity variable including a part of the orography in such a way that the bottom boundary condition is homogeneous. This new “W” vertical variable leads to a new vertical divergence variable in the implicit system. 3. The exploration of new stability constraints on the design of vertical discretization schemes inspired by modern derivation of the primitive equations.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SPDY1.1	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	on hold
SPDY1.2	The use of a “W” vertical variable defined as the difference between the true vertical speed and its value at the surface leads to an homogeneous rigid bottom condition in non-linear model and allows the minimization of the residual in the prognostic pressure equation. A relaxation towards the classical vertical speed with vertical levels is prescribed. This formulation has entered the code on a developement branch and stability was improved in first simulations. Further testing will be performed on different situations (currently an AROME domain over the Alps with 375m horizontal resolution is used)	**FaVo**	**t-code**

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SPDY1.1	FaVo	Documentation on the QE code	base code in CY46T1

ALADIN/HIRLAM/LACE WorkPackage description : SPDY2

WP number	Name of WP
SPDY2	Development of methods for solving the implicit equation in gridpoint space.
WP main editor	**Ludovic Auger, Sander Tijm**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
LuAu, PiBe	Ludovic Auger, Pierre Bénard	Météo-France	13
ThBu	Thomas Burgot (ext)	Météo-France	11
DaDe	Daan Degrauwe	RMI Belgium	2.5
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
SPDY2.1	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, ThBu	
SPDY2.2	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, JoVi, DaDe, ThBu	
SPDY2.3	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, DaDe	
SPDY2.4	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
SPDY2.2			tbd

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SPDY2.1	LuAu	Scientific publication	
SPDY2.3	LuAu	Scientific publication	
SPDY2.4	PiBe	Scientific publication	

ALADIN/HIRLAM/LACE WorkPackage description : SPDY3

WP number	Name of WP
SPDY3	Horizontally Explicit Vertically Implicit (HEVI) methods with ALADIN-NH core
WP main editor	**Ludovic Auger, Sander Tijm**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
FaVo	Fabrice Voitus	Météo-France	0.5

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
SPDY3.1	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	on hold
SPDY3.2	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	on hold

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SPDY3.1	FaVo	Scientific paper with a toy model	papers from Charles Colavolpe's PhD have been published

ALADIN/HIRLAM/LACE WorkPackage description : SPDY4

WP number	Name of WP
SPDY4	Physics-dynamics interface
WP main editor	**Daan Degrauwe, Sander Tijm**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PaMa, FaVo	Pascal Marquet, Fabrice Voitus	Météo-France	2
DaDe	Daan Degrauwe	RMI Belgium	0.5

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
SPDY4.1	Explore possibility to derive the energy equation without relying on the entropy budget.	PaMa	Documentation
SPDY4.2	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
SPDY4.3	Implement and test outcomes of DY4.1 and DY4.2 in ALADIN.	DaDe	Code in t-cycle

t-code deliverables

Task	Responsible	Cycle	Time
SPDY4.3	DaDe		Autumn 2019

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SPDY4.1	PaMa	Documentation	Spring 2019
SPDY4.2	PaMa	Documentation	Spring 2019

ALADIN/HIRLAM/LACE WorkPackage description : SPDY5

WP number	Name of WP
SPDY5	Development of LAM components in Atlas
WP main editor	**Daan Degrauwe, Sander Tijm**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
DaDe	Daan Degrauwe	RMI Belgium	3
CoCl	Colm Clancy	Met Eireann	4

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
SPDY5.1	Follow ECMWF's Atlas developments and keep existing LAM features alive.	DaDe	Code on ECMWF git-repository
SPDY5.2	Impact of projection (map factors and compass) on numerical operators like finite-volume derivatives.	DaDe	Code on ECMWF git-repository
SPDY5.3	Atlas (C++) interface to the LAM spectral transforms (“etrans”).	DaDe	Code on ECMWF git-repository
SPDY5.4	Run ESCAPE dwarfs (e.g. sparse solver GCR, SL advection) in LAM configuration.	DaDe	Code
SPDY5.5	Develop Atlas-based test program ("dwarf") for non-spectral multigrid-preconditioned iterative Helmholtz solver for NH dynamics in LAM geometry. This task serves several purposes: (i) familiarization with Atlas; (ii) implementation of necessary LAM features in Atlas; (iii) stand-alone scalability test program; (iv) test program for maintenance of LAM features in Atlas (e.g. to be included in Mitraillette).	DaDe, ???	Code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SPDY5.1	DaDe	Put code in git-repository of the ESCAPE project. Atlas will become publicly available at the end of this project.	(continuous)
SPDY5.2	DaDe	Put code in the ECMWF git-repository.	(not clear yet if it should be part of Atlas or not, e.g. for IFS-FVM the global map factors are not calculated in Atlas)
SPDY5.3	DaDe	Put code in the ECMWF git-repository.	End of 2019
SPDY5.4	DaDe	Put code in the ECMWF git-repository.	End of 2019
SPDY5.5	DaDe		End of 2020

ALADIN/HIRLAM/LACE WorkPackage description : SPDA1

WP number	Name of WP
SPDA1	Basic data assimilation setup
WP main editor	**Piet Termonia, Maria Monteiro, Alena Trojakova**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MSG, MaKo	Malgorzata Szczech-Gajewska (3), Marcin Kolonko (2)	IMGW Poland	5
HaBe, WaKh	Haythem Belgrissi (4), Wafa Khalfaoui (2)	INM Tunisia	6
MaMo	Maria Monteiro (4)	IPMA Portugal	4
ZaSa, FaHd	Zahra Sahlaoui, Fatima Hdidou	Maroc Meteo	2
AlGu, MeSe, YeCe	Alper Güser (1), Meral Sezer (2), Yelis Cengiz (1)	MGM Turkey	4
AnBo,BoTs	Andrey Bogatchev, Boryana Tsenova	NIMH Bulgaria	6
MOAM, GhCh	Mohand Ouali Ait Meziane (3), Ghiles Chemrouk (2)	ONM Algeria	5
AlDe	Alex Deckmyn (3), Idir Dehmous (3)	RMI Belgium	6

WP objectives

The objectives 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.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SPDA1.1	**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	technical reports
SPDA1.2	**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	code and technical reports
SPDA1.3	**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	code and technical reports
SPDA1.4	**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	reports
SPDA1.5	**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	scientific reports
SPDA1.6	**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
SPDA1.1		all countries have access to SYNOP (local in some cases), TEMP and AMDAR data	End 2020
SPDA1.2	MaMo	code and technical note	End 2020
SPDA1.3		joint local porting/validation in CY43T2 - SYNOP, TEMP, AMDAR	End 2020
SPDA1.4		joint local implementation of OBSMON	End 2020
SPDA1.5		basic scripts KIT (oi_main) for testing and validation	End 2020
SPDA1.6	AlDe, MaMo	discussion on combined oi_main+3D-Var basic set of scripts	End 2020

ALADIN/HIRLAM/LACE WorkPackage description : DA1

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
JaSa, PaEs	Jana Sanchez (3) Carlos Geijo (1)	AEMET Spain	
AlTr, AnBu	Alena Trojakova, Antonin Bucanek	CHMI Czech	5
AnSt	Antonio Stanesic	DHMZ Croatia	2
XiYa, MaDah	Xiaohua Yang(CARRA), Mats Dahlbom (2)	DMI Denmark	2
WaKh	Wafa Khalfaoui	INM Tunisia	3
RoAz, OlVi, RoRa, MaMi,PeDah, ZQW	Roohollah Azad (Alertness), Roger Randriamampianina (CARRA, Alertness, 1), Mate Mile (Alertness), Per Dahlgren (CARRA, PRECISE), Zheng Qi Wang (CARRA, PRECISE)	MET Norway	1
PiBr, ClFi, PhCh, OlGu	Pierre Brousseau, Claude Fischer, Philippe Chambon, Oliver Guillet	Météo-France	15
MaLi, MaRi, SuHa, JeBo	Magnus Lindskog(3, Microsat), Martin Ridal (2.5, PRECISE), Susanna Hagelin (0.5), Jelena Bojarova (iOBS, CARRA)	SMHI Sweden	6
BeSt	Benedikt Strajnar (1)	ARSO Slovenia	1

WP objectives

Refine and optimize the system based on 3D-Var 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, Brand, with and without large scale mixing) with respect to the balance between control variables and the increments evolution in the first 2 h 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) (note: this task has been started in 2017 with very promising results of the concept with single observation test), 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 (supermodding).
- 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 (1), MaRi (2), RoRa & RoAz (Alertness), JaSa (3), WaKh, SuHa (1), MaMi, OlGu	Code and scientific note
DA1.2	Evaluate the impact of different formulations of the background error statistics (EDA, Brand, Forcing, LETKF) on the balance between control variables and on spinup.	RoRa, AnBu, JeBo, MaRi(0.5)	Scientific note
DA1.3	Initialization techniques: compare the available tools (IDFI, and IAU), and implement the variational constraint technique implied by the semi-implicit system.	CaGe (1), JaSa	Code and scientific note
DA1.4	Large scale information: Compare various mechanisms for taking the large scales into account (Jk, LSMIX, via preconditioning, …). Consider increased lateral boundary condition coupling frequency.	MaDah (2), XiYa, AnSt (0.5)	Scientific note
DA1.5.1-2	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 (1), NiGu, MaLi (2)	Scientific note
DA1.6	Maintenance and evolution of the state-of-art [Arome/Alaro/Harmonie-Arome] [3D-Var/BlendVar] assimilation cycles: follow-on changes of e-suites, exchange about scientific results between Aladin and Hirlam partners. Maintenance of the reanalysis script system.	PiBr, ClFi, PhCh, RoRa, BeSt(1), AlTr, AnBu, AnSt(1.5), PeDah, ZQW	Scientific note
~~DA1.7~~	~~3h cycling appropriate for BlendVAR~~	~~AlTr~~	~~Scientific note~~
~~DA1.8~~	~~B-matrix appropriate for BlendVAR~~	~~AnBu~~	~~Scientific note~~

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA1.1	MaRi	Report on optimal (background and observation) uncertainties representation in high resolution data assimilation (HRDA). Report on reduced representativeness error of observations in HRDA.	end 2020
DA1.2	JeBo	Report on impact of differently computed B matrices	end 2020
DA1.3	CaGe	new and/or updated codes for variational non-hydrostatic balance	end 2020
DA1.4	MaDah, XiYa	Possible solution for use in the reference system about large scale consideration.	end 2020
DA1.5	RoRa	Specific Harmonie branch ready for OSSE.	end 2020
DA1.6	PiBr, ClFi, RoRa, BeSt, AlTr	Technical report	end 2020
~~DA1.7~~	~~AlTr~~	~~Technical report~~	~~End of 2019~~
~~DA1.8~~	~~PaEs~~	~~Scientific note~~	~~End of 2019~~

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 (4), Carlos Geijo (2)	AEMET Spain	6
XiYa	Xiaohua Yang (0.75)	DMI Denmark	0.75
JaBa	Jan Barkmeijer (1.5)	KNMI Netherlands	1.5
RoSt, RoRa, RoAz	Roel Stappers, Roger Randriamampianina (Alertness), Roohollah Azad (1, Alertness)	MET Norway	1
LoBe, YaMi, ThMo, PiBr, EtAr, CeLo, OlGu, MaDe	Loik Berre, Yann Michel, Thibaut Montmerle, Pierre Brousseau, Etienne Arbogast, Cécile Loo, Oliver Guillet, Mayeul Destouches	Météo-France	55
JeBo, NiGu, MaLi, PaMa	Jelena Bojarova (2), Nils Gustafsson(4), Magnus Lindskog (3, microsat), Paulo Madeiros (1)	SMHI Sweden	10
IsMo, VaCo	Isabel Monteiro (2), Vanda Costa (0.5)	IPMA Portugal	2.5

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 4D-EnVar which has been done earlier within the HIRLAM model (e. g. Gustafsson and Bojarova 2014). Tuning of the balance constraint in the minimization 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 CSC. 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	Towards operational implementation of 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, physics in high and low resolution runs and trajectory truncations); address the convergence issue in the variational scheme; investigate ways to improve 4D-Var computational performance and scalability (see also SY1); Exploit the benefit of tendency increments; compare the performance and accuracy of 4D-Var with that of 3D-Var in both short-range (0-48h) and nowcasting applications; 4D-Var tested and tuned in CY43h2.2.	MaLi (2), MaRi (2), RoRa & RoAz (Alertness), JaSa (3), WaKh, SuHa (1), MaMi, OlGu, PaMa(1)	Code and scientific note
DA2.2	Evaluate performance of HybridEnVar algorithm with regards to the different ensemble generation strategies (EDA, BRAND, LETKF) and tune the algorithm on its optimal performance. Options to consider: scale decomposition in space-scale dependent localisation, time lagging strategy for ensemble, 4DVAR framework, initialisation.	JeBo (2), RoRa, NiGu (2)	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. Cloud variables in control vector and B.	LoBe, EtAr, YaMi, ThMo, PiBr, MaDe	code and scientific notes
DA2.4	EDA: AEARP and AEARO: scientific improvements in both EDA systems. Porting of the deterministic DA and of the EDA systems to MF's new HPC (both ARPEGE and AROME).	LoBe, OlGu, YaMi, ThMo, PiBr	code and scientific notes
DA2.5	Use of Ensemble DA information in an AROME-based variational system.	YaMi, PiBr	code and scientific notes

DA2.6	Start to enhance HybridEnVar formulations with a particle filter like functionalities to allow more efficient use of observations in presence of non-Gaussian and non-linear uncertainties.	JeBo	code and scientific notes
DA2.7	Extend LETKF to assimilate all kind of available observations, either operationally and in research mode. Compare LETKF performance with operational 3DVAR paying attention to proper spin up tests. Exploring possible developments of LETKF: more control variables (find the possibility of having more control variables in AROME-based DA), estimation of observation errors or estimation of bias corrections of observations.	CaGe (2), PaEs (4)	code and scientific notes

t-code deliverables

Task	Responsible	Cycle	Time
DA2.1	JaBa, RoSt	CY47 or later	end 2019, some of the tasks in 2020
DA2.2	JeBo, PaEs	CY47 or later	end 2020
DA2.3	LoBe, EtAr, YaMi	prototyping now in CY46T1, later porting to newer version (CY47 or CY48?)	2018-2022
DA2.4	LoBe, YaMi	CY47T1 - CY48	end 2020
DA2.5	YaMi, PiBr	CY47T1	2019

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA2.1	MaLi	update of 4D-Var script and namelists for operational application	end 2019, some of the tasks to be continued in 2020
DA2.2	JeBo	update of Harmonie script and namelists	end 2019
DA2.3	LoBe	scientific papers about progress with OOPS/EnVar	end 2020
DA2.4	LoBe, PiBr, YaMi	1)scientific papers, namelists for the MF suites; 2)mirror suites on MF's new HPC	end 2020
DA2.5	YaMi, PiBr	scientific papers or notes, OLIVE scripting adaptations	end 2020
DA2.6	JeBo	Scientific paper	end 2020
DA2.7	PaEs, CaGe	Scientific paper	end 2020

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, PaEs	Joan Campins(2), Maria Diez(2), Jana Sanchez(4), Angeles Hernandez (2) , Pau Escriba (2)	AEMET Spain	12
BeSt, PeSm, ViSv	Benedikt Strajnar (2.25), Peter Smerkol (1.5), Vito Svagelj (2)	ARSO Slovenia	5.75
AnBu, AlTr	Antonin Bucanek (2.5), Alena Trojakova (3)	CHMI Czech	5.5
AnSt	Antonio Stanesic	DHMZ Croatia	1.5
MaDah, HeVe	Mats Dahlbom(2), Henrik Vedel(0.5)	DMI Denmark	2.5
DaSch	David Schönach (3), Erik Gregow (iOBS)	FMI Finland	3
SiTh	Sigurdur Thorsteinsson (3)	IMO Iceland	3
HaBe, WaKh	Haythem Belgrissi (4), Wafa Khalfaoui (3)	INM Tunisia	7
IsMo, MaMo	Isabel Monteiro(2), Maria Monteiro (1)	IPMA Portugal	3
SdH, WiVe, GJM, JaBa	Siebren de Haan(2), Wim Verkleij(6), Gert-Jan Marseille(2), Jan Barkmeijer(1)	KNMI Netherlands	11
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui	Maroc Meteo	3
EoWh	Eoin Whelan(0.75)	MET Eireann	0.75
RoAz, MaMi, ChrEl, LiSe, RoRa, PeDah, ZQW	Roohollah Azad (EuM ET), Máté Mile (Alertness), Christoffer Elo (3), Lise Seland Graf (MetCoOp), Roger Randriamampianina (1), Per Dahgren (CARRA, PRECISE), Zheng Qi Wang (CARRA,PRECISE)	MET Norway	4
FrGu, NaFo, ViGu, PaMo, ViPo, ErWa, MaMa, JFMa	Frank Guillaume, Nadia Fourrié, Patrick Moll, Vivien Pourret, Maud Martet, J.-F. Mahfouf, 1 or 2 newcomers in the GMAP/OBS team (provisional accounting of 2 times 0.5 FTE)	Météo-France	30
DuAk, YeCe	Duygu Aktaş (1), Yelis Cengiz (2)	MGM Turkey	3
KJR, ViHo, ZsKo, NeHU	Katalin Javorne Radnoczi (1), Viktoria Homonnai (3), Zsofia Kocsis (1), New Hungarian Team (5)	OMSZ Hungary	10
GhCh	Ghiles Chemrouk	ONM Algeria	2
MaDe,MiNe, MaIm, KaCa	Maria Derkova (2), Michal Nestiak (6), Martin Imrisek (2), Katarina Catlosova (6)	SHMU Slovakia	16
MaLi, MaRi, GuHa	Magnus Lindskog(2), Martin Ridal(4.5, iOBS), Günther Haase(1)	SMHI Sweden	7.5
FlMe, PhSc	Florian Meier (1), Philip Scheffknecht (1)	ZAMG Austria	2
LeDC, AlDe, IdDe	Lesley de Cruz (2) Alex Deckmyn (1) Idir Dehmous (3)	RMI Belgium	6

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	Assist local implementation of radar data assimilation: 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. Adaptation of BATOR to radar Doppler winds and reflectivities from OPERA. Perform monitoring and assimilation of various European radars.	AnBu, AnSt (1.5), FlMe, MiNe, MaDah (1), MaRi (2.5), WiVe (6), RoAz, GuHa (1), AlTr, FrGu, MaMa, JFMa, ZaSa (1), JaBa (1), JaSa (2), GhCh, BeSt(1), PeSm (1.5), ViSv (2), ChrEl, KJR, NeHU, DuAk	T-codes and scientific note
DA3.2	Aircraft-derived data (ADD): assist implement Mode-S (EHS and MRAR) pre-processing; refine quality control, thinning/super-obbing; evaluate VarBC for ADD; impact assessment.	BeSt(0.25), JK, SdH (2), EoWh (0.25), RoRa, FlMe, FrGu, ViPo, PaMo, MaRi (1), MaLi (1), MaDe, KaCa, PhSc, RoAz, LiSe, MaDi (1), LeDC, AlDe, IdDe, ViHo (2)	T-codes and scientific note

DA3.3	Ground-based GNSS ZTD: further elaborate the assimilation of ZTD data without or with less anchoring observations; refine white- or blacklisting of GNSS stations and use of VarBC; conduct impact study; apply with 4D-Var.	JaSa (2), SiTh (1.5), MaLi, HeVe (0.5), PaMo, MaIm, FaHd, BeSt (0.5), MiIm, FlMe, LeDC, AlDe, IdDe, YeCe	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~~; Explore and add in the reference system the use of scatterometer data from international agencies: Chinese-French Oceanographic SATellite (CFOSAT), the Chinese HY-2A/B, the Indian OSCAT-3 and ASCAT-A/B/C.	MaMi, GJM (2), IsMo(2), BeSt(0.5)	T-codes and scientific note
DA3.5	AMV: Assist the implementation of both locally (NWCSAF HRW software) and EUMETSAT generated AMV's; elaborate the blacklisting procedure.	FM, MMi, DaSch(3), TL, AnHe (1), ZsKo, ViHo, RoRa (0.5), PeDah	T-codes and scientific note
DA3.6.1-3	Clear-sky radiances: 1) Seviri, 2) IASI and CrIS, and 3) ATOVS, ATMS, and MWHS: improve the estimation of surface emissivity and skin temperature to allow their assimilation over sea ice and land, including radiances from low-peaking channels. Support the operational implementation for both emissivity handling approache and observations.	MaMo, MaDah(1), SiTh (1.5), MaDi (1), JoCa (2), WaKh, AnHe (1), MaLi (1), RoRa(0.5), ZQW	T-codes and scientific note
DA3.7	Cloud-affected radiances: IASI and CrIS radiances: allow assimilation of cloud-affected radiances (e.g. CO2 slicing).	ViGu, NaFo	T-codes and scientific note
DA3.8	Assist local implementation of high-resolution radiosondes: optimize local pre-processing, extend observation operator.	EoWh (0.25),HaBe, MaMo	T-codes and scientific note.
DA3.9	Assimilation of surface pressure observations; Address quality control and bias correction; Perform impact assessment; promote data exchange between NMS's	PaEs (2), EoWh, RoRa, JaSa, RoSt, MaLi (1), ErGr (2), MaRi(2,iOBS)	T-codes and scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA3.1	MaDa	CY46T1 or later	end 2020
DA3.2	EoWh, RoRa, PM	CY46T1 or later	end 2020
DA3.3	MaLi, HaBe, PaMo	CY46T1 or later	end 2020
DA3.4	GJM	CY46T1 or later	end 2020
DA3.5	EoWh, RoRa	CY46T1 or later	end 2020
DA3.6.1	MaDi	CY46T1 or later	end 2020
DA3.6.2	SiTh, RoRa	CY46T1 or later	end 2020
DA3.6.3	MaDa	CY46T1 or later	end 2020
DA3.8	EoWh	CY46T1 or later	end 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA3.1	MaMo	Common pre-processing and Bator for (OPERA) radar data.	end 2020
DA3.4	IsMo	Report about the implementation of the different observations	end 2020
DA3.61-3	MaLi	Report about the impact assessment	
DA3.7			
DA3.9	Pa Es	Report about system (scripts and namelist) update and impact assessment	end 2020

ALADIN/HIRLAM/LACE WorkPackage description : DA4

84

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
KaHi	Kasper Hintz (1)	DMI Denmark	1
CdB, SdH, JaBa	Cisco de Bruijn (1), Siebren de Haan (1)	KNMI Netherlands	2
FaHd	Fatima Hdidou	Maroc Meteo	2
MaDi, CaGe, AnHe	Maria Diez (2), Carlos Geijo(1), Angeles Hernandez(1)	AEMET Spain	4
IsMo	Isabel Monteiro	IPMA Portugal	0.5
MaLi, SuHu, MaRi	Magnus Lindskog (1pm, Rs-Aeolus, MetCoOp), Susanna Hagelin (2, Rs-Aeolus), Martin Ridal (iOBS)	SMHI Sweden	3
RoRa, RoAz, RoSt	Roger Randriamampianina(Alertness), Roohollah Azad (Alertness, PRODEX, 1pm), Roel Stappers (1 + iOBS)	MET Norway	2
PaMo, ErWa, FrGu, NaFo, PhCh, FaDu, ViPo, ChPa, JFM, FrVi, ZiSa, GuTh, MaBa	Patrick Moll, Maud Martet, Frank Guillaume, Nadia Fourrié, Philippe Chambon, Vivien Pourret, Christophe Payan, Jean-François Mahfouf, Francesca Vittorioso, Zied Sassi, Guillaume Thomas, Marylis Barreyat, or 2 newcomers in the GMAP/OBS team	Météo-France	55
OlCa	Olivier Caumont	Météo-France	3
MOAM	Mohand Ouali Ait Meziane	ONM Algeria	4
FlMe, FlWe	Florian Meier (0.5), Florian Weidle (0.5)	ZAMG Austria	1
BeSt, PeSm	Benedikt Strajnar (1.5), Peter Smerkol (2)	ARSO Slovenia	3.5
YeCe	Yelis CENGİZ	MGM Turkey	1
MaIm	Martin Imrisek (2)	SHMU Slovakia	2

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 relies 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 (radiances, GPS-derived data, aircraft humidity observations, delays in telecommunication links due to rain). 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	Participant abbrev.	Type of deliverable
DA4.1	All-sky radiances: 1) Implement the use of all-sky radiances starting with ATOVS and SSMI/S (ECMWF method) in CY43h2. 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 (1), PhCh, MaBa, JFM	Codes and scientific note
DA4.2	GNSS slant delay: assist the implementation and porting process to the common code, conduct impact study with 3D/4D-Var.	SdH (1), FlWe, FlMe, MaIm (2)	Codes and scientific note
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: further explore the potential of volunteered observations from crowd and smartphones.	KaHi (1), CdB (1), RoSt (1), MaRi	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 (see also DA3.4). Significant work was done in 2018 with Aeolus L2 HLOS winds.	RoAz, FruG, ViPo, ChPa, FrVi, IsMo(0.5), AnHe (1), MaLi (1), SuHa (2)	Codes and scientific note
DA4.6	Use of AMDAR humidity observations: Continue to monitor, optimize the QC and perform impact study of AMDAR humidity in the ALARO/AROME 3D-Var.	FlMe, MaDi (2), PaMo, MOAM, YeCe	Code and scientific note
DA4.7	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	Scientific note
DA4.8	Assimilate wind data from recreational hot-air balloon flights in HARMONIE-AROME	CdB (1)	Code and Scientific note
DA4.9	Start to explore the different products from SAF/NWC in DA processes (short-range and nowcasting applications)	CaGe (1)	Scientific note
DA4.10	Assimilation of attenuation in telecommunication microwave links due to rain: Refine the preprocessing to efficiently separate dry and wet attenuation. Develop suitable observation operator to assimilate retrieved rain rates (initially as saturated humidity observation in rainy areas).	BeSt (1.5), PeSm (2)	Codes and Scientific note
DA4.11	Assess use of radar polarimetric data; more European OPERA data for assimilation in Arome-France	OlCa, MaMa	scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA4.1	1) RoRa, 2-3) PhCh	CY46T1 or later	end of 2020
DA4.2	SdH, FlMe, FlWe	CY46T1 or later	end of 2020
DA4.3			

DA4.4	KaHi	CY47T1	End of 2020
DA4.5.1-4	1-RoAz, FrGu	CY47T1	End of 2020
DA4.6	MaDi, PaMo	CY47T1	End of 2020
DA4.7	NaFo	CY47T1	End of 2019
DA4.8	CbB	CY46T1	End of 2020
DA4.9	CaGe	CY46T1	End of 2020
DA4.10		CY46T1	End of 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA4.1	RoRa	Report about the status of the implementation of All-Sky in CY43h2	end of 2020
DA4.7		Technical report	End of 2019
DA4.8	CdB	Technical report	End of 2019
DA4.11	CdBOlCa, MaMa	Technical report	end of 2019

ALADIN/HIRLAM/LACE WorkPackage description : DA5

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

Table of participants

Participant Abbrevia	Participant	Institute	PersonMonth or External project
CaGe	Carlo Geijo (3)	AEMET Spain	3
BeSt	Benedikt Strajnar (1)	ARSO Slovenia	1
PaBe, AlTr	Patrick Benacek (2), Alena Trojakova (1), Antonin Bucanek	CHMI Czech	4.25
XiYa, ClPe	Xiaohua Yang (1), Claus Pedersen(3)	DMI Denmark	4
ErGr, DaSch	Erik Gregow (3), David Schönach (1)	FMI Finland	4
SdH, JaBa	Siebren de Haan (1), Jan Barkmeijer (1.5)	KNMI Netherlands	2.5
FaHd, ZaSa	Fatima Hdidou (0.5), Zahra Sahlaoui (1.5)	Maroc Meteo	2
RoAz, RoRa	Roohollah Azad (MetCoOp), Roger Randriamampianina (1)	MET Norway	1
AnVa	Aniko Varkonyi	OMSZ Hungary	3
PiBr, NiMe	Pierre Brousseau, Nicolas Merlet	Météo-France	2
MiNe, MaDia	Michal Nestiak(1), Martin Dian (1)	SHMU Slovakia	2
MaLi, ToLa, JeBo	Magnus Lindskog (1), Tomas Landelius (SEA), Jelena Bojarova (1)	SMHI Sweden	2
FlMe, PhSc	Florian Meier (5), Phillip Scheffknecht (3)	ZAMG Austria	8
EoHa	Eoghan Harney (0.5)	MET Eireann	0.5
LeDC	Lesley De Cruz	RMI Belgium	2

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 (e.g.: Mode-S, GNSS ZTD, GNSS STD, Radar, Seviri, surface, ...): monitor observations usage; evaluate quality, promote data exchange from local observation networks.	SdH (1), ErGr (1), FlMe (3), PhSc(2), BeSt, MiNe, MaMo, ZaSa, MaDia, AnVa	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.	AnVe, ZaSa, FaHd, LeDC (2), FlMe, BeSt (1), PiBr, NiMe	Codes and scientific note
DA5.3	Comprehensive testing in CY40h1.1.1 and CY43h2 of the Field Alignment and the Variational Constraints (FA+VC) algorithms in the context of data assimilation for NWC, preferably with sub-hourly updates.	CaGe (3), RoRa (1)	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 in CY43h2.	ErGr (1), DaSch (1), MaLi (1), ToLa, 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 with 4DVAR or 3DVAR for coarse resolution domain with internally nested high resolution downscaling using radar data nudging.	RoAz, XiYa (1), ErGr (1), ClPe (3), FlMe(2), PhSc(1), MiNe, MaDia, MaLi, JaBa (1.5), NiGu, CaGe (2), LeDC (3), EoHa (0.5)	Codes and scientific note
DA5.6	Implement HybridEnVar scheme based on tracking of structures for a very short forecast ranges (0-9h) base on the EPS and alpha control variables.	JeBo	Codes and scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA5.4	ErGr	CY46	end 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA5.1	SdH	Code ported to CY43h2	end of 2020
DA5.2	PiBr	script and code	end of 2020
DA5.3	CaGe, RoRa	script and code in CY43h2	end of 2020
DA5.5	RoAz, XiYa	script and code updated for CY43h2	end of 2020
DA5.6	JeBo	script and code	end of 2020

ALADIN/HIRLAM/LACE WorkPackage description : DA6

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
RoSt, RoRa, DaSM	Roel Stappers (COM1.2), Roger Randriamampianina, Daniel Santos-Munoz	MET Norway	
ClFi, EtAr, AlMa, REK, FlSu, FaVo, HaPe	Claude Fischer, Etienne Arbogast, Alexandre Mary, Ryad El Khatib, Florian Suzat, Fabrice Voitus, Harold Petithomme	Météo-France	25
DaDe	Daan Degrauwe	RMI Belgium	0.5
JeBo	Jelena Bojarova (probably starting in 2020)	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 after the completed move of their HPC to Bologna, though probably not in the very first e-suite there (so perhaps rather 2021, tbc.).

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. The aim of this task is to rearrange the IFS/ARPEGE/LAM codes in order to enable the 4D-VAR and 3D-VAR configurations to work within the OOPS framework including VarBC and VarQC.	AlMa, REK, ClFi, RoSt, EtAr, FlSu, HaPe	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, including tests of OOPS objects. NOTE: visit by Roel to MF will take place on 14-31/10/19	EtAr, AlMa, RoSt	non t-codes
DA6.4	Full-POS for OOPS & use of the new configuration "903"	REK	t-codes
DA6.5	Specific ARPEGE/LAM issues for re-factoring (DDH, LBC)	AlMa, FaVo, HaPe	t-codes
DA6.6	Digital filter initialization in OOPS	DaDe	t-codes
DA6.7	Develop large scale error constraint, allow centred FGAT. Hybrid-envar, LAM 4DVAR. Implement alpha-control variables for LAM and LETKF scheme. Find flexible technical solutions for consistent ensemble variational DA/EPS schemes.	RoSt, JeBo	t-codes
DA6.8	Participation to technical coordination meetings (incl with EC) or specific workshops, if any are organized. Participation to IFS/Arpège coordination meetings where now OOPS status and progress (at EC and MF) are being discussed regularly (note: the OOPS Board had ceased to exist end of 2018).	ClFi, EtAr, AlMa, RoSt, DaSM, HaPe	minutes of meetings

t-code deliverables

Task	Responsible	Cycle	Time
DA6.1	ECMWF/MF coordination (coordinators)	CY47T1, CY48	end 2019 / spring 2020 resp.
DA6.2	EtAr & RoSt	?	?
DA6.4	REK	CY47T1, CY48	end 2019 / spring 2020 resp.
DA6.5	AlMa	CY47T1, CY48	end 2019 / spring 2020 resp.
DA6.6	?	?	?
DA6.7	RoSt	after CY47T1	2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA6.3	EtAr for MF prototypes	updated prototype codes (outside IFS cycles)	?
DA6.8	ClFi, RoSt, RoRa	minutes of meetings, technical notes, presentations for workshops	as relevant

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**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
JaSa	Jana Sanchez (1)	AEMET Spain	1
AlTr	Alena Trojakova	CHMI Czech	2
FlMe	Florian Meier	ZAMG Austria	0.5
BjAm, MaDah	Bjarne Amstrup (3), Mats Dahlbom(2)	DMI Denmark	5
SiTh	Sigurdur Thorsteinsson (1)	IMO Iceland	1
ViHo	Viktoria Hommonnai	OMSZ Hungary	1
IsMo	Isabel Monteiro (0.5), Manuel Mendes (1)	IPMA Portugal	1.5
EoWh	Eoin Whelan (3)	MET Eireann	3
RoRa	Roger Randriamampianina (1)	MET Norway	1
HeBe, FrGu, DoPu, DoRa	Hervé Benichou, Frank Guillaume, Dominique Puech, Dominique Raspaud	Météo-France	7
MaLi, MaRi, PaMa	Magnus LIndskog(CARRA), Martin Ridal (PRECISE), Paulo Medeiros (CARRA, PRECISE)	SMHI Sweden	ext

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	Re-evaluate COPE with SAPP BUFR and CY46 and report on its potential, in particular address requirements for observations not currently assimilated by ECMWF : 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), MaDah (1), BjAm (3)	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. At the current stage, this tool is developed to be use with local environment only; 2) DFS to evaluate the impact of observations on the analyses. A common (play-file) solution is needed to allow the existing solution for wider use; 3) ObsMon to monitor the use and contribution of observations in DA. Single (up to date) development stream requested; 4) MTEN to evaluate the impact of observations on the forecast model, assist the explorartion and maintenance of the existing solution under the Harmonie branch; 5) Improve the tool providing the verification against all observations; 6) Feasibility study of FSOI in LAM. Update the wiki page on "how-to" on the different tools.	JaSa (1), MaDah (1), MaLi, MaRi, RoRa (0.5), HeBe, DoPu, DoRa, PaMa, SiTh (1), FlMe (0.5)	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. Implementation of ADM Aeolus was a good cooperation Meteo France and MET Norway in 2018-2019.	EoWh (1), FrGu, RoRa (0.5)	non-T-codes
DA7.4	Assist the local implementation of SAPP for local observations pre-processing with special focus on observations not yet handled by the package.	EoWh(1), IsMo(0.5) MaMe(1)	non-T-codes
DA7.5	OPLACE: Maintenance and development of observation preprocessing software (before the conversion to ODB - task DA7.3), new observation types data handling , data acquisition and observation format conversion tools, simple QC, TAC2BUFR migration.	AlTr, ViHo	non-T-codes, report

T-code deliverables

Task	Responsible	Type of deliverable	Time
DA7.1	EW	CY46T1	end 2019

Non-t-code deliverables

Task	Responsible	Cycle	Time
DA7.1	EoWh	CY46	end 2020
DA7.2	DoRa	Technical report	end 2020
DA7.2.1		script and code	end 2020
DA7.2.2	RoRa	script and play-file	end 2020
DA7.2.3	PaMa	script and code (CI)	end 2020
DA7.2.4	RoRa	CI	end 2020
DA7.3	EoWh	CY46	end 2020
DA7.4	IsMo, EoWh	Technical note	end 2020
DA7.5	AlTr	Technical note	end 2020

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
REK, GhFa	Ryad El Khatib, Ghislain Faure	Météo-France	1.5

WP objectives

Aspects deserving further study are: the handling of coupling files, 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 number of horizontal interpolation steps and the vertical interpolation used in the boundary generation.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DY1.1	Simplify the procedure for getting coupling files from IFS: development and optimisation of configuration 903, operational implementation and testing, documentation, testing of different options and quality control. The options include: quadratic or cubic grid output, horizontal and vertical resolution, the role of clim files, treatment of prognostic variables (condensates), surface, and possibly other.	REK, GhFa	t-code, configuration, documentation

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

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	2
JoVi	Jozef Vivoda	SHMU Slovakia	2
AlCr	Alexandra Craciun	Meteo Romania	2

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. Several new definitions of the vertical motion variable were proposed (w5,w6) with consequencies on the prognostic equations system and on the time-space discretization of this system.The implementation of these definitions has to be finalized and tested.

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, PeSm, AlCr	t-code
DY2.2	To reformulate the nonhydrostatic nonlinear model using new definitions for the vertical motion variables to obtain simple bottom boundary condition with the goal to increase the overall stability of the scheme.	JoVi, PeSm	t-code
DY2.3	Formulation of Euler equations as the increment of hydrostatic primitive equations. The aim is to add nonhydrostaticity gradually and omit it where numerical stability is questionable (with vertical or time from start dependency).	JoVi, PeSm	t-code

t-code deliverables

Task	Responsible	Cycle	Time
DY2.1		CY48T1	end 2020
DY2.2	JoVi	CY48T1	end 2020
DY2.3	JoVi	CY48T1	end 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY2.2	JoVi	Report, ideal cases study	end 2020
DY2.3	JoVi	theoretical study	end 2020

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
JoVi	Jozef Vivoda	SHMU Slovakia	2
PeSm	Petra Smolíková	CHMI Czech	4

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 study the compatibility of direct inversion in the Helmholtz solver done after elimination of all variables but horizontal divergence (solution proposed by Voitus) with finite element vertical discretization and possibly address remaining problems. To externalize the whole vertical discretization from other model parts.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DY3.1	VFE in NH model with direct inversion of the Helmholtz solver	JoVi	report
DY3.2	The externalization of the vertical discretization.	JoVi	t-code
DY3.3	Cleaning and pruning of the VFE (vertical finite element) code, removal of research branches which did not show usability.	PeSm	t-code

t-code deliverables

Task	Responsible	Cycle	Time
DY3.1	PeSm		depends on the availability of direct Helmholtz solver
DY3.2	JoVi		longer term task
DY3.3	PeSm	CY48T1	end 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY3.1	PeSm	Report	depends on the availability of direct Helmholtz solver

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	0.5

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.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DY4.1	To check the convergence of the iterative algorithm for trajectory search in kilometric resolutions, draw conclusions.	PeSm	non-t-code
DY4.2	To test the influence of the explicit definition of vertical coordinate eta on the accuracy of vertical interpolation.	PeSm	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY4.1	AlCr	Report	end 2020
DY4.2	AlCr	Report	end 2020

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
KEL, NaMa	Kamal El Karouni, Najla Marass	Maroc Meteo	1.5
YvBo, ErBa, YaSe, RaHo, PaMa, JMP, CeLo, InEt, OlJa, AnHu, AlMa, FlSu	Yves Bouteloup, Eric Bazile, Yann Seity, Rachel Honnert, Pascal Marquet, Jean-Marcel Piriou, Cécile Loo, Antoine Hubans, Alexandre Mary, Florian Suzat : CNRM/GMAP	Météo-France	18
ChLa, SeRi, BeVi, QuLi	Christine Lac, Sébastien Riette, Benoit Vié, Quentin Libois : CNRM/GMME	Météo-France	22
HaDh	Hajer Dhouioui	INM Tunisia	8
MoMo, AbAm, AbBa	Mohamed Mokhtari (1), Abdenour Ambar (2), Abdelhak Bahlouli (2	ONM Algeria	5
ChWi	Christoph Wittmann	ZAMG Austria	1

WP objectives

Improve the physics parameterizations and diagnostics of the MF NWP configurations, which encompass AROME-France CMC, 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. Porting of AROME configurations to next MF HPC.	YaSe, ErBa, RaHo, SeRi, HaDh (6), KEL, ChWi	doc, t-code
PH1.2	LIMA microphysics scheme development	BeVi, ChLa, HaDh(2)	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	FrBs, YaSe, YvBo, AbAm, MoMo, AlMa	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, AbBa	doc
PH1.6	Model diagnostics: further improve DDH	YvBo, JMP, , NaMa	notes, t-code
PH1.7	ARPEGE-specific aspects: reassess the scientific choices and the code of the convection scheme PCMT (collaboration with climate group), intensive tests of the IFS deep convection scheme, intercomparison effort of parameterization schemes between ARPEGE and IFS (PhD of AnHu / orography & GWD by FlSu), linearized physics (microphysics aspects) in 4D-VAR. Porting of ARPEGE configurations to next MF HPC.	JMP, YvBo, PaMa, ErBa, CeLo, AnHu, FlSu	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, DaMa, SaVi	Javier Calvo (1.5), Daniel Martin (8)	AEMET Spain	9.5
KPN	Kristian Pagh Nielsen	DMI Denmark	2
LaRo	Laura Rontu	FMI Finland	3
JPP	Joni-Pekka Pietikainen (ext)	FMI Finland	ext
WdR, SaTi, ToKe	Wim de Rooij (3.5), Sander Tijm (2.5), Tosca Kettler (2)	KNMI Netherlands	8
EmGl, EwMA	Emily Gleeson (2), Ewa McAufield (?)	MET Eireann	2
BJE, TeVa	Bjorg Jenny Engdahl (ext), Teresa Valkonen (ext)	Met Norway	ext
KII, MeSh	Karl-Ivar Ivarsson (2.5), Meto Shapkalijevski (2.25)	SMHI Sweden	4.25
DaBe	Danijel Belusic (ext)	SMHI Sweden	ext
HaSo	Harald Sodemann (ext)	University of Bergen	ext

WP objectives

Verify and where possible improve the general representation of clouds and microphysics (tasks PH2.1 - PH2.3). Weaknesses like the too weakly precipitating cold outbreak convection and the too strong precipitation near convective updrafts accompanied by too small areas with weak precipitation 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 PH2.4 – PH2.6). 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 PH2.7 – PH2.9). Especially the generally too low nighttime temperatures, the failure to represent observed very low temperature minima in very cold conditions and too thick, persistent and widespread fog will be targeted.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH2.1	Convection: Study the impact of physics and dynamics choices on the initiation and strength of deep convection. Vertical diffusion has been shown to have some negative impact on the initiation of deep convection (improvements implemented in CY43). Other areas that have been studied so far are the role of the surface (soil moisture data assimilation and evaporation, also implemented in CY43) and microphysics (no formation of cloud ice/snow/graupel for showers warmer than -15°C). The last item has to be studied further, together with the impact of the shallow convection scheme. In addition the impact of vertical resolution (90 levels) on the physics, especially on clouds, has to be studied.	JaCa, SaTi, KII, WdR, MeSh	t-code, configuration, report
PH2.2	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. This is strongly linked to QA2. KNMI part should be ready in Q2 2020.	WdR, PeBa	t-code, Report
PH2.3	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 when CY47 becomes available for development. PhD work on the implementation of the Thompson microphysics scheme as a research option.	KII, BJE, DaMa, DaBe	t-code, proposal for namelist changes
PH2.4	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). Explore the possibility to derive the cloud cover from the subgrid fraction and the optical depth of each water species.	KII, EmGl	t-code, namelist
PH2.5	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, installation and testing of ECRAD in HARMONIE-AROME, based on preliminary work ongoing within MesoNH framework and in AROME-France	LaRo, EmGl, KPN	t-code, namelist

PH2.6	Improve the usage of (fixed) climatological aerosol concentration and optical properties for any radiation scheme based on CAMS climatology from ECMWF. Further testing of near real-time CAMS aerosol both for the direct radiative effect of aerosols and the cloud-aerosol interactions.	LaRo, KPN, JPP, DaMa	t-code, namelist
PH2.7	SBL/Fog studies: Study the influence of vertical resolution on decoupling in SBL and fog formation, study cloud microphysics (drizzle) and radiation interactions. For persistent fog when no fog is observed and vice versa, conditional (no other clouds should be present) cloud initialization can be considered.	TVa, WdR, PeBa, EmGl, EwMA, SaTi, ToKe	t-code, namelist
PH2.8	Surface influence on SBL (see also SU3.10): Study in CY43 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. Also study the impact of the translation from model level/surface to observed levels. Study the relation between XRIMAX-problems and other parameters in surface		t-code, namelist
PH2.9	Study the relative role and interaction of parametrizations and data assimilation on the SBL and possibly the erroneous initiation of deep convection.		

t-code deliverables

Task	Responsible	Cycle	Time
PH2.2	WdR		Q2 2020
PH2.3	KII		
PH2.4	KPN		
PH2.5	LaRo		
PH2.6	LaRo/JPP		
PH2.7	TeVa, WdR		

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH2.1	JaCa	Proposed namelist changes	
PH2.2	GeMo, WdR	Report	Q4 2019 (WdR)
PH2.3	KII	Namelist	
PH2.4	KPN	Namelist	
PH2.5	LaRo	Namelist	
PH2.6	LaRo/JPP	Namelist	
PH2.7	TeVa, WdR	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 (2), Neva Pristov (2)	ARSO Slovenia	4
RaBr, JaMa	Radmila Brožkova, Jan Mašek, Filip Savbik	CHMI Czech	20
MaHr	Mario Hrastinski	DHMZ Croatia	3.5
BoBo, PiSe	Bogdan Bochenek, Piotr Sekula	IMGW Poland	2
LuGe	Luc Gerard	RMI Belgium	10
MaDi	Martin Dian (2), Maria Derkova (0.5)	SHMU Slovakia	2.5

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 (see PH5).

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	RaBr, JaMa, PeSm (2)	doc, t-code
PH3.2.2	TOUCANS scheme – mixing length computation	MaHr (2.5), 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	NePr (2), ~~DuAk, DaDe,~~ MaDi, JaMa, RaBr	doc, t-code
PH3.8	ALARO-1 validation and maintenance	JaMa, RaBr, MaDe	t-code
PH3.9	Improvement of DDH tool for ALARO	MaHr (1)	t-code

t-code deliverables

Task	Responsible	Cycle	Time
PH3.*	JaMa, RaBr	cy4?	regularly

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	0.25
EoWh, EmGl	Eoin Whelan, Emily Gleeson (2)	MET Eireann	2
BJE	Bjorg Jenny Engdahl	Met Norway	ext
ErBa, YvBo, RaHo, JMP	Eric Bazile, Yves Bouteloup, Rachel Honnert, Jean-Marcel Piriou	Météo-France	8
DaDe	Daan Degrauwe	RMI Belgium	0.5

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.
In 2018/2019 a new version of MUSC has been developed at Met Eireann, which is much more user friendly. However, no special reference cases are part of this system, so the old test cases have to be added (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 (task PH2.4). LACE would also like to use the MUSC environment for validation and development purposes. Therefore a training and working days will be organized by LACE in cooperation with other ALADIN and HIRLAM users.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH4.1	Maintain and upgrade “common MUSC” system	DaDe, RaHo, JMP	
PH4.2	Create and add (idealized) test cases	BJE, WdR, JMP, EmGl, EoWh	
PH4.3	MUSC training and working days		

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

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

ALADIN/HIRLAM/LACE WorkPackage description : PH5

WP number	Name of WP
PH5	Model Output Postprocessing Parameters
WP main editor	**Maria Derkova**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
NePr. JuCe	Neva Pristov, Jure Cedilnik	ARSO Slovenia	2
BeSa	Bent Hansen Sass	DMI Denmark	0.5
SaTi	Sander Tijm	KNMI Netherlands	0.5
ClFi	Claude Fischer	Météo-France	0.5
FrBo	Francois Bouyssel	Météo-France	0.5
AnSi	Andre Simon	SHMU Slovakia	6
MaDe	Maria Derkova	SHMU Slovakia	0.5
ChWi	Christoph Wittman	ZAMG Austria	0.5
ClWa	Clemens Wastl	ZAMG Austria	1
FlWe	Florian Weidle	ZAMG Austria	2.5
OlJa	Olivier Jaron	Météo-France	9
InEt	Ingrid Etchevers	Météo-France	6
RaHo	Rachel Honnert	Météo-France	1
JMP	Jean-Marcel Piriou	Météo-France	1

WP objectives

An increasing need for new postprocessing parameters out of NWP systems for many applications such aeronautics, green energy sector, automatic forecasting and for various end-users is reflected in an ongoing work at every NMS. To avoid possible work duplication it is suggested to - at least partially - coordinate activities on the postprocessing developments. The aim of the WP is to prepare a working plan on the implementation of the selected parameters into the common code, and start to implement some of the parameters. More details after the code training in Sept. 2019

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH5.1	preparation of a workplan for implementation of selected postprocessing parametersinto the code	all	work plan
PH5.2	implementation of selected parameters into the common code, tuning and validation	FlWe(0.5),ChWi(0.5)	t-code, reports
PH5.3	Model output diagnostics: improvment of new visibility diagnostic, discrimination of precipitation type, lightning diagnostic, convective gust, test nearest point "interpolation" in Full-POS	InEt, JMP, FlWe(1)	notes, t-code
PH5.4	Model outputs diagnostics for aviation end-users (turbulence, icing index, coud base and top, top of convection, tropopause and jet altitude, thermal vertical velocity for gliders pilot	OlJa, RaHo, ClWa(1),FlW	notes, t-code
PH5.5	Diagnostic fields	NePr (PH5), JuCe (PH5), ChWi	t-code

t-code deliverables

Task	Responsible	Cycle	Time
PH5.2	??	CY48??	2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH5.1	??	work plan	2020
PH5.2	??	reports, notres	2020

ALADIN/HIRLAM/LACE WorkPackage description : SU1

WP number	Name of WP
SU1	Algorithms for surface assimilation
WP main editor	**Rafiq Hamdi and Patrick Samuelsson**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
EkKo	Ekaterina Kourzeneva	FMI Finland	3
FaHd, ZaSa	Fatima Hdidou (1.5), Zahra Sahlaoui (1.5)	Maroc Meteo	2
ÅsBa, MaHo, TrAs, YuBa	Åsmund Bakketun (1, AROME-Arctic*), Mariken Homleid (1.5), Trygve Aspelien (2), Yurii Batrak	MET Norway	4.5
CaBi, ErBa	Camille Birman, Eric Bazile	Météo-France	8
RaHa, JaDp	Rafiq Hamdi (0.25), Jan De Pue (0.5)	RMI Belgium	0.75
ViTa, JaSl	Viktor Tarjani (3), Jarmila Slavkova (2)	SHMU Slovakia	5
PaSa, JeBo, MaLi, ToLa	Patrick Samuelsson (1), Jelena Bojarova (1), Magnus Lindskog (ext), Tomas Landelius (ext)	SMHI Sweden	2

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.

HIRLAM specific plans:
Short term goals (2020): In cy43h, a development branch of new surface physics and SEKF assimilation in combination with TITAN/gridPP is running and is evaluated. Continue to evaluate which flavour of EKF works best for diffusion soil scheme and explicit snow scheme. Continue the use of conventional observations for assimilation (i.e. T2m and Rh2m) and gradually introduce satellite products, e.g. LAI. Continue also the development of assimilation of sea-ice surface temperature in SICE. In addition to CANARI HIRLAM is also exploring the potential of TITAN/gridPP as an alternative surface analysis system which allows e.g. a flexible utilisation of crowdsourcing data (e.g. Netatmo).
Medium to long term goals (2020-2021): Includes investigation of evolving B, checking of time scales and length of assim window + potential assimilation enhancements. Include assimilation of FLake variables. Work towards EnKF system coupled with the atmosphere including assimilation of raw radiances for surface control variables.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU1.1	Develop/assess SEKF for soil, snow and vegetation using SYNOP data in combination with the diffusion soil and the Explicit Snow (ES) schemes in SURFEXv8.1		see subtasks
SU1.1.1	Activate, develop and evaluate SEKF for diffusion soil scheme as implemented in SURFEX/SODA.	ÅsBa, EkKo, MaLi, JeBo, PaSa, MaHo, TrAs	t-code
SU1.1.2	Activate, develop and evaluate SEKF for explicit snow scheme as implemented in SURFEX/SODA.	EkKo, MaLi, JeBo, PaSa, MaHo, TrAs, ÅsBa	t-code
SU1.1.3	Combine the development in SU1.1.1-1.1.2 and set up a pre-operational system based on (S)EKF for soil, snow and vegetation.	EkKo, MaLi, JeBo, PaSa, MaHo, TrAs, ÅsBa	report
SU1.1.4	Validation of EKF surface assimilation with SYNOP observations using force-restore method	ViTa, JaSl	report
SU1.2	For CANARI in HARMONIE-AROME, (i) solve inconsistencies in land/sea mask between SURFEX and climate files (ii) implement new weigted T2m, Rh2m, and snow for first guess (based e.g. on patch info) (iii) exclude need of climatological snow density. For AROME & ARPEGE, item (iii) "exclude need of climatological snow density" will be further explored.	CaBi, EkKo, ErBa, MaMo	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 and ARPEGE.	EkKo, MaHo, LaRo CaBi	t-code report
SU1.4	Develop/assess EKF for sea ice, using satellite products in combination with the SICE scheme.	YuBa, EkKo	t-code, code

SU1.5	Investigating the use of Land-SAF product when building the Jacobian matrix for EKF/STAEKF	RaHa, JaDp	t-code, configuration report
SU1.6	Surface analysis strategy for AROME-MAROC	ZaSa, FaHd	configuration report
SU1.7	Test and further develop the surface analysis tool based on gripp and TITAN in combination with SODA. This is an alternative to CANARI.	TrAs, ÅsBa	t-code, code, report
SU1.8	Continue earlier externally financed work on EnKF and assimilation of raw radiances (e.g. soil moisture, temperature and snow (smos)). Also investigate/develop needed forward models like CMEM/HUT work with SSMIS, AMSR2 and MWRI and Sentinel 1 SAR data. Investigate/design methodology for a consistent generation of upper air and surface perturbations. Address problem of sampling of a long term memory error. Enhance EnKF methodology to be suitable for a multy-patches approach. In the long term this will lead towards consistent surface and upper-air surface perturbations.	ToLa, JeBo, EkKo	t-code, code, report

t-code deliverables

Task	Responsible	Cycle	Time
SU1.1.1	ÅsBa	SURFEX code contribution	Mid 2020
SU1.1.2	PaSa	SURFEX code contributions	End 2020
SU1.2	EkKo, MaMo	SURFEX code contributions, cy46+	Mid 2020
SU1.3	EkKo	SURFEX code contributions, cy46+	Mid 2020
SU1.4	YuBa	SURFEX code contributions, cy46+	Summer 2019
SU1.5	RaHa	SURFEX code contributions	End 2021
SU1.7	TrAs	cy4x contribution, SURFEX code contributions	End 2019
SU1.8	ToLa	SURFEX code contribution	End 2019

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU1.1.3	PaSa	Evaluation report	End 2019
SU1.1.4	ViTa	Evaluation report	End 2018
SU1.2	MaHo	Namelist changes	Summer 2019
SU1.3	CaBi	Evaluation report	End 2019
SU1.4	YuBa	HARMONIE script system	Summer 2020
SU1.5	RaHa	Evaluation report	End 2021
SU1.6	ZaSa	Evaluation report	End 2019
SU1.7	TrAs	Harmonie script system, Evaluation report	Mid 2020
SU1.8	ToLa	HARMONIE script system report	End 2020

ALADIN/HIRLAM/LACE WorkPackage description : SU2

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
EkKo	Ekaterina Kourzeneva	FMI Finland	1
BiCh	Bin Cheng (2 and UC INTAROS*)	FMI Finland	2
LaRo	Laura Rontu	FMI Finland	2
BoPa	Bolli Palmason	IMO Iceland	1
JoDV	John de Vries	KNMI Netherlands	1.75
MaHo	Mariken Homleid (MetCoOp*, AROME-Arctic*)	MET Norway	ext
YuBa	Yurii Batrak	MET Norway	ext
TrAs	Trygve Aspelien (1)	MET Norway	1
CaBi	Camille Birman	Météo-France	3
ZiSa	Zied Sassi	Météo-France	11
JaDp	Jan De Pue	RMI Belgium	0.5
MaLi	Magnus Lindskog (ext)	SMHI Sweden	ext
HeKo	Helga Toth Kollathne	OMSZ Hungary	2
BaSz	Balázs Szintai	OMSZ Hungary	2
JaVu	Jasmin Vural	ZAMG Austria	5
StSc	Stefan Schneider	ZAMG Austria	3

WP objectives

New observations will be introduced from satellite products/radiances representing surface temperature (land/sea-ice/lake), Leaf-Area Index (LAI), surface soil moisture, snow cover, snow water equivalent, snow albedo (land, sea-ice), sea-ice cover. First, retrieved products (e.g. soil moisture or LAI) 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/compare available satellite snow-extent (Cryoland Snow cover, NOAA IMS sonw cover, NSICD MODIS MOD10A1) (and possibly Snow-Water Equivalent products) to identify their pros and cons. Some might become available through ODB.	MaLi, EkKo, BoPa, TrAs	report
SU2.2	Examine available satellite soil moisture products for use in surface data assimilation. The description of the sub-tasks contains the following information: [soil moisture product] - [assimilation method] - [SURFEX version].		
SU2.2.1	[ASCAT, AMSR-2, ...] - [EnKF] - [8.1]	ToLa	report, code
SU2.2.3	[SCATSAR-SWI (combined Sentinel-1 + ASCAT product)] - [sEKF] - [8.1]	StSc, JaVu	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 radiation/temperature products for use in surface data assimilation. The description of the sub-tasks contains the following information: [satellite product] - [assimilation method] - [SURFEX version].		
SU2.5.1	[LSA-SAF radiation] - [tbd] - [tbd]	RaHa, JaDp	report
SU2.5.2	[surface temperature products (MSG, Sentinel-3)] - [(s)EKF] -[8.1]	StSc	report
SU2.5.3	[LSA-SAF albedo] - [tbd] - [AROME]	CaBi, ZiSa	report
SU2.5.4	[satellite derived skin temperature] - [tbd] - [AROME]	ZiSa	report
SU2.6	Examine the use of amateur weather obbservations (like Netatmo) in surface assimlation, using gridpp (instead of CANARI)	TrAs, JoVB	report
SU2.7	Examine available snow products for use in surface data assimilation. The description of the sub-tasks contains the following information: [snow product] - [assimilation method] - [SURFEX version].		
SU2.7.2	[H-SAF] - [sEKF] - [8.1]	LaRo, TrAs	
SU2.7.3	[SYNOP snow reports] - [CANARI] - [tbd]	CaBi	report

SU2.8	Examine available vegetation products for use in surface data assimilation. The description of the sub-tasks contains the following information: [satellite product] - [assimilation method] - [SURFEX version].		
SU2.8.1	[Proba-V LAI] - [sEKF] - [8.1] daily updated LAI for AROME-Hungary	BaSz, HeKo	report
SU2.9	Examine available evapotranspiration products for use in surface data assimilation. The description of the sub-tasks contains the following information: [product] - [assimilation method] - [SURFEX version].		
SU2.9.1	[LSA SAF] - [sEKF] - [8.1]	JoDV	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 2020
SU2.2.3	StSc	publication	End of 2019
SU2.3	YuBa	report, script changes	2020 or later
SU2.4	BiCh	report	End 2020
SU2.5.1	RaHa	tbd	2020/2021
SU2.5.2	StSc	report	Q2 2020
SU2.5.3	CaBi	report	End 2019
SU2.5.4	ZiSa		
SU2.6	TrAs	report	2020
SU2.7.2			
SU2.7.3			
SU2.8.1	BaSz	report	End 2019
SU2.9.1	JoDV	report	Autumn 2020

ALADIN/HIRLAM/LACE WorkPackage description : SU3

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
SaVi	Samuel Viana	AEMET Spain	4
SuPa	Suzana Panežić	DHMZ Croatia	2
EkKo, OlSa	Ekaterina Kourzeneva (0.25), Olli Saranko (1)	FMI Finland	1.25
BoPa, SiTh	Bolli Palmason (2), Sigurður Þorsteinsson (0.25)	IMO Iceland	2.25
JodVr	John de Vries	KNMI Netherlands	2.75
MaHo, TrAs, ÅsBa	Mariken Homleid (1), Trygve Aspelien (1), Åsmund Bakketun (1, AROME-Arctic*)	MET Norway	3
EmGl	Emily Gleeson	MET Eireann	1.5
PaLM, AaBo, MaMi	Patrick Le Moigne, Aaron Boone, Marie Minvielle : CNRM/GMME	Météo-France	12
YaSe, GhFa, CaBi, AdNa	Yann Seity, Ghislain Faure, Camille Birman, Adrien Napoly : CNRM/GMAP	Météo-France	16
BaSz	Balázs Szintai (2)	OMSZ Hungary	4
OuDo	Oussama Douba	ONM Algeria	3
RaHa, JaDp, FrDu, StCa	Rafiq Hamdi (4), Jan De Pue (4), François Duchene (3), Steven Caluwaerts (1)	RMI Belgium	12
PaSa, JeBo, KIIv, DaBe	Patrick Samuelsson (1 MetCoOp*), Jelena Bojarova (0.5), Karl-Ivar Ivarsson (0.5), Danijel Belusic (climate projects*)	SMHI Sweden	2
StSc	Stefan Schneider	ZAMG Austria	2
MaDi	Martin Dian	SHMU Slovakia	2
JaMa	Ján Mašek	CHMI Czech	1

WP objectives

Explore and validate available SURFEX physics components:

With respect to the nature tile, more advanced assimilation methods (SU1) and more types of observations (SU2) will also make it possible to utilize more physically based surface components, 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. The DIF scheme also offers a number of hydrological options. For NWP we have now have the new physicis componenets in ISBA of SURFEXv8, mainly ES, DIF, MEB running. During the next year continue to validate and explore the potential of the new physics. Assessing the potential of the new options should be done in tight connection to the corresponding assimilation methods (SU1). Next step in surface processes to consider may be prognostic LAI which should provide better surface resistance and transpiration contorl and opens up for assimilation of LAI products.

Continue routine validation against in-situ data and complement 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).

For the ocean part e.g. continue to evalute the efect of new ECUME flux formulations. 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. The 1D sea ice model GELATO will be tested in Arpege and also in experimental arctic AROME.

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. Thus, new processes can be explored which are not necesseraliy connected to an assimilation method. For example, the lake model FLake is currently operational in a HARMONIE-AROME setup without data assimilation. The situation is similar for towns where the Town-Energy Balance (TEB) model is running.

Observations needed for the validation are partly provided by QA3, via tools like Monitor and HARP. However, some observations are not general enough to be provided by QA3. For example, local soil temperature profiles can be very valuable but such data are not wide enough in time and in space to be part of a general validation tool.

Scientifically consistent transition of ALARO-1 from directly called 2-level ISBA to SURFEX should be finalized, addressing also observed fibrillation issues. Goal is to have the necessary changes entering t-cycle (NWP SURFEX commit).

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, EmGl, JodVr, TrAs, PaLM, AaBo, MaMi, YaSe, OuDo, CaBi, RaHa, JaDp, FrDu,StCa	see subtasks

SU3.1.1	In climate mode, over different domains, examine biases in cy43 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, CaBi	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, 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, 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.	OlSa	report, configuration
SU3.4	Test DIF in the framework of (S)EKF assimilation of SWI (Soil Water Index) in SURFEX 8.1, combined with AROME CY40/CY43. 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
SU3.7	Test and validate new ECUME formulations for the sea tile in cy43h. Look more specifically into how the cloudiness (optical depth) is affected over sea areas.	SaVi, KIIv, (KrPN, EmGl)	report, configuation
SU3.8	Implementation of ALARO-1 screen level interpolation in SURFEX	SuPa, JaMa	report, t-code (?)
SU3.9	Validation of ALARO-1 with SURFEX (ISBA), implementation of effective roughness.	MaDi, JaMa	report, t-code
SU3.10	Understand and improve the stable surface layer regime (XRIMAX, stability functions, roughness, diagnostics, vertical (lowest model level) and horizontal resolution). See also PH2.8.	MaHo, DaBe, SiTh	
SU3.11	Activate and evaluate the orographic roughness parametrization (OROTUR).		

t-code deliverables

Task	Responsible	Cycle	Time
SU3.1.2	SaVi, PaSa	SURFEX code contributions, namelist changes	Summer 2020
SU3.2	JodVr	SURFEX code contributions	End of 2020
SU3.8	SuPa, JaMa	SURFEX code contributions	Autumn 2020 (?)
SU3.9	MaDi, JaMa	SURFEX code contributions	Autumn 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU3.1.1	SaVi	report	Spring 2020
SU3.1.3	PaSa	report	End 2020
SU3.2	JodVr	script changes, namelist changes	Summer 2020
SU3.3	OlSa	report, namelist changes	End 2020
SU3.4	StSc	report	End 2020
SU3.5	GhFa	report	
SU3.6	BaSz	report	End 2020
SU3.7	SaVi	report, namelist changes	Summer 2020
SU3.8	SuPa	report	End 2020
SU3.9	MaDi	report	End 2020

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	Kristian Pagh Nielsen	DMI Denmark	1
LaRo, EkKo, BiCh	Laura Rontu (1), Ekaterina Kourzeneva (0.25), Bin Cheng (2 and UC INTAROS*)	FMI Finland	3.25
BoPa	Bolli Palmason	IMO Iceland	1
YuBa	Yurii Batrak	MET Norway	ext
AaBo	Aaron Boone : CNRM/GMME	Météo-France	4
PaSa	Patrick Samuelsson	SMHI Sweden	1
EmGl	Emily Gleeson	MET Eireann	0.5
RaHa,JaDP	Rafiq Hamdi (0.25) Jan De Pue (4)	RMI Belgium	4.25

WP objectives

Further develop SURFEX model components:

In SURFEX there is continuous development ongoing of existing, under-developed, or still missing, processes and diagnostics methods. During this RWP period development by NWP team members is planned to include:
an increase in sophistication for the Simple Ice scheme (SICE), a glacier model for permanent snow/glacier areas, the lake model FLake, orography related radiation (ORORAD) and turbulence/drag (OROTUR) aspects, the Multi-Energy Budget (MEB) scheme for open land, additional parametrization of fractional snow and improvement of winter aspects in the urban model TEB, new formulations of vegetation roughness. 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	t-code
SU4.2	Further development of SICE (effect of melt pond, snow-ice formation, improvement of albedo scheme). Dynamic (advection) of sea ice.	YuBa, BiCh, EkKo	t-code
SU4.3	Evaluate the orographic radiation (ORORAD) implementation in cy43 and apply further modifications and developments.	LaRo, EmGl	t-code
SU4.5	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
SU4.6	A wind-farm parametrization (momentum drag) has been developed by KNMI. This parametrization should be implemented in HARMONIE-AROME.	Carlos at DMI?	
SU4.7	Improvement of the phenology in ISBA-Ags.	RaHa, JaDP	t-code

t-code deliverables

Task	Responsible	Cycle	Time
SU4.1	BoPa	SURFEX code contributions	End 2020
SU4.2	YuBa	SURFEX code contributions	End of 2020
SU4.3	LaRo	SURFEX code contributions	End of 2020
SU4.4	LaRo	SURFEX code contributions	End of 2020
SU4.5	PaSa	SURFEX code contributions	End of 2020
SU4.7	RaHa	SURFEX code contributions	End of 2020

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, Patrick Samuelsson and Rafiq Hamdi**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
SaVi	Samuel Viana	AEMET Spain	2
SuPa	Suzana Panežić	DHMZ Croatia	1
EkKo, LaRo, OlSa	Ekaterina Kourzeneva, Laura Rontu, Olli Saranko (2)	FMI Finland	2
BoPa	Bolli Palmason (2.0 BoPa)	IMO Iceland	2
JodVr	John de Vries	KNMI Netherlands	1
PaSa	Patrick Samuelsson	SMHI Sweden	1
RaHa	Rafiq Hamdi	RMi Belgium	1
DuUs	Duygu Üstüner	MGM Turkey	1
KPNi	Kristian Pagh Nielsen	DMI Denmark	2
EmGl	Emily Gleeson	MET Eireann	1
DiTz, FlSu	Diane Tzanos, Florian Suzat	Météo-France	7

WP objectives

Assess and improve quality of surface characterization:
The surface physiography data currently used are:
1) different versions of ECOCLIMAP (v2.2 - v2.5), some of them with corrected physiography for lakes, and ECOCLIMAP-SG (Second Generation)
2) the FAO, HWSD and Soilgrids sand, clay and soil-organic carbon databases,
3) national datasets on tree height for Sweden, Finland and Norway,
4) the GMTED2010 orography,
5) the Global Lake DataBase (GLDB) v3.
We will continue to critically examine these databases and correct if possible, fixing errors, using national data, etc. We will develop parts of the code (PGD, scripts) to use these maps in different versions of the system. We will study their impact and monitor the 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. We will coordinate possible physiography development with other consortia via EWGLAM/SRNWP.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU5.1	ECOCLIMAP activities. ECOCLIMAP cover map, corrections and studying the impact. Corrections mainly for Iceland, Greenland, Svalbard. Correction of sea pixels deep in the continent (Iran, Mongolia). Examining for Croatia and Spain. Studying of urban areas. Improving ecoclimap over china	BoPa, EkKo, PaSa, SuPa (1), SaVi, TeVa, KPNi + SaTi (in frames of QA), RaHa, DuUs	database, reports, documentation, code
SU5.2	Soil maps activities. HWSD and Soilgrids corrections and studying impact. Corrections will be done mainly for Denmark, Iceland, Greenland, Svalbard, Scandinavia. Examining for Iberia. Orography GMTED2010 in MF models.	BoPa, KPNi, EkKo, PaSa, MaHo, TeVa, SaVi, ??? + SaTi (in frames of QA), FlSu	database, reports, documentation, code
SU5.3	Tree height data activities. Tree height data upgrades and studying the impact. The work is planned for 2020, after upgrades of the database for Norway.	MaHo, TeVa, PaSa, ????	report, code
SU5.4	Lake database (GLDB) Participate in GLDB developments and studying the impact.	EkKo, BoPa, LaRo, PaSa	database, code, reports
SU5.5	ECOCLIMAP SG activities. Examining and and participate in developments	TeVa, SaVi, JodVr, EkKo, OlSa, EmGl, DiTz	report
SU5.6	Evaluation and possible reformulation and/or tuning of roughness length. E.g., the concept of displacement height is not used in SURFEX. Do we need to re-tune the grass-land roughness with new ECOSG LAI...How about EGOSG tree height and its influence on roughness. What about snow roughness, is the small values used now realistic. These questions are partly related to the stable surface layer issue in SU3.10.	PaSa, SaVi	report, t-code

t-code deliverables

Task	Responsible	Cycle	Time
SU5.6	PaSa	cy?	End 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU5.1	BoPa, PaSa	updated databases, related h-code, reports	End 2020

SU5.2	BoPa	updated databases, related h-code, reports	End 2020
SU5.3	MaHo	report	End 2020
SU5.4	EkKo	report, updated databases, related h-code if necessary	End 2020
SU5.4	LaRo	report	End 2020
SU5.5	TeVa	report	End 2020

ALADIN/HIRLAM/LACE WorkPackage description : SU6

WP number	Name of WP
SU6	Coupling with sea surface/ocean
WP main editor	**Neva Pristov and Patrick Samuelsson**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MaLi, PeSm, AnFe, BeSt, JuCe	Matjaž Ličer (1), Peter Smerkol (1), Anja Fettich (1), Benedikt Strajnar, Jure Cedilnik	ARSO Slovenia	3
ErTh, NiSz, MaMu, CyPa, YuBa	Erin E. Thomas (12pm, external project), Nicholas Szapiro (12pm, external project), Malte Müller (1pm, external project), Cyril Palerme (2pm, external project), Yurii Batrak (4pm external project)	MET Norway	ext
BaKSa	Basanta Kumar Samal (SEAI (Sustainable Energy Authority Ireland)*)	MET Eireann	ext

WP objectives

Assess and improve quality of surface characterization:
- Currently the sea surface in our operational models 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. A good starting point is to test ocean-atmosphere and atmosphere-wave coupled system separately.

The first application was using ALARO, 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. On this system, extensive validation has been already performed for 2-way ocean-atmosphere coupling (ALARO CMC, POM) from both ocean and meteorological points of view. As ocean model POM was replaced with NEMO and ALARO is going to use SURFEX, the coupling should be redone via SURFEX-OASIS. This action is planed to start in 2019, but very probably only in 2020. In 2019, coupling of Wave Wind Model III with ALARO has been started, continuation and validation continue in 2020.

During 2018 AROME/SURFEX was coupled to the wave model WW3 via OASIS by Lichuan Wu (SMHI) in a development version of cy43 of the HARMONIE-AROME configuration. Continued work on this setup is ongoing in Norway and Ireland. Norway focuses on coupling of the HARMONIE-AROME with WW3 and CICE, ROMS in cy43. Irland is working on coupling Harmonie-AROME with WW3 and target to make it operational for Ireland region by 2020. Further plans are to couple with ROMS ocean model (AROME-WW3-ROMS).

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU6.1	Code and Technical documentation of coupling process (update for cy43)		
SU6.1.1	Adaptations on atmospheric part ALARO (update for cy43)	PeSm (1)	t-code
SU6.1.2	Adaptations on atmospheric part HARMONIE-AROME		t-code
SU6.1.3	Technical documentation (update for cy43)	PeSm	documentation
SU6.2	Construct cycling with OASIS coupler in cy43	PeSm, JuCe	code (local)
SU6.3	~~2-way coupling ALARO and POM~~	~~BeSt, JuCe, MaLi~~	report
SU6.4	Ocean model coupled via OASIS		
SU6.4.1	Ocean model NEMO off-line coupling with ALARO	MaLi, AnFe	report
SU6.4.2	Ocean model NEMO coupled with ALARO using SURFEX-OASIS	MaLi (1), PeSm	code/script
SU6.4.3	Evaluation of coupled system ALARO/NEMO	MaLi, BeSt, JuCe	report/paper
SU6.5	Implementation of ocean wave model		
SU6.5.1	Wave model WAM coupled via OASIS in ALARO - techical implementation and validation	PeSm, AnFe(1)	code (local)
SU6.5.3	Coupling and implementation of wave model WWM in ALARO		
SU6.6	Set-up of coupled system ALARO/NEMO/WAM	MaLi, BeSt, JuCe	
SU6.7	Set-up of coupled system HARMONIE-AROME-WW3-ROMS		
SU6.7.1	Develop an operational HARMONIE-WW3 setup of cy43h	BaKSa	t-code
SU6.7.2	Development of HARMONIE-WW3-ROMS, and with SICE in Norway	ErTh, NiSz, MaMu, CyPa, YuBa, BaKSa	t-code

t-code deliverables

Task	Responsible	Cycle	Time
SU6.4.1		cy4?	
SU6.5.1		cy4?	
SU6.7.1	BaKSa	cy43	End of 2020
SU6.7.2	MaMu, BaKSa	cy??	2022

Non-t-code deliverables			
Task	**Responsible**	**Type of deliverable**	**Time**
SU6.1	PeSm	Documentation, code	
SU6.2	PeSm	Algorithm, code	
~~SU6.3~~	~~MaLi~~	~~Paper, scripts~~	
SU6.4.1	MaLi	operational	end of 2018
SU6.4.2	MaLi	implementation, test	

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
LaRa, LaDe, LuRo, MaPl, YaMi, PiCe, CaLa, OlNu, GhFa, YaHa, MeWi	Laure Raynaud, Laurent Descamps, Lucie Rottner, Mathieu Plu, Yann Michel, Pierrick Cébron, Carole Labadie, Olivier Nuissier, Ghislain Faure, Yamina Hamidi, Meryl Wimmer : CNRM/GMAP	Météo-France	35
FrBt, HuMa, SaRa	François Bouttier, Hugo Marchal, Sabine Radanovics (ext) : CNRM/GMME	Météo-France	30
OlMe, MiZa, MaTa	Olivier Mestre, Michael Zamo, Maxime Taillardat : DirOP/COMPAS	Météo-France	9

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-France system: follow adaptations for e-suites, porting to next MF HPC & mirror suite	LaRa	non-t-code
E1.2	Probabilistic post-processing (including probabilistic objects), calibration and verification	LaRa, LuRo, MaPl, OlMe, MiZa, MaTa, HaPe, FrBt, HuMa, SaRa, YaHa	non-t-code
E1.3	Link with AEARO: use Arome EDA perturbations in PEARO initial conditions	LaRa, YaMi, FrBt	non-t-code
E1.4	Model perturbations for PEARO: assess SLHD, SPPT, SPP etc.	LaRa, LaDe, FrBt, MeWi	t-code
E1.5	Improvements of the global EPS (PEARP), as the coupling system of PEARO	PiCe, CaLa	t-code
E1.6	Development of an Arome-based EPS system for (some of) the Arome Overseas models. Start exploring specific topics for such "PEARO-Overseas" (perturbation strategies, impact of specific tunings)	OlNu, GhFa	technical notes at this stage

t-code deliverables

Task	Responsible	Cycle	Time
E1.4	LaRa		
E1.5	PiCe		

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E[1-6]	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
JaKa, KaHa	Janne Kauhanen (3), Karoliina Hamalainen (3)	FMI Finland	6
SvdV, JaBa,WdR	Sibbo van der Veen (2.5), Jan Barkmeijer (1), Wim De Rooy (0.75)	KNMI Netherlands	4.25
AlHa	Alan Hally	MET Eireann	2.5
ILF, TeVa	Inger-Lise Frogner (3), Teresa Valkonen (ext)	MET Norway	3
Alfons Callado	AlCa (0.5)	AEMET Spain	0.5
GeSm, MiVa	Geert Smet (1) Michiel Vanginderachter (6)	RMI Belgium	7
UlAn	Ulf Andrae (1)	SMHI Sweden	1

WP objectives

Study ways to represent uncertainty in the atmospheric model and how to best incorporate this into HarmonEPS.
-The SPPT scheme will be tested more extensively, and various options for improvement will be explored.
-The SPP approach (Stochastically Perturbed Parametrization scheme) will be continued, where sensitive parameters are perturbed using a spatio-temporal pattern.
-There are many different sources of model error, hence it is not presently clear if SPP will be sufficient. Neither is it not known whether one approach to model error description is better than another. For some time to come, it might be beneficial to combine SPP and SPPT to cover a greater part of the uncertainties.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.1.1	SPPT: Look into new ways of constructing SPPT. Some possibilities are: combining several spatio-temporal scale patterns or by exploring more possibilities in SPG; using a 3D pattern generator instead of the current 2D; Perturbing independently each parameterisation, as well as partial SPPT; Perturb independently each variable, as well as different uncertainties in different variables; Better adjusting the PBL and upper atmosphere SPPT tapering for LAM-EPS, or even not apply it at all. Combine with SPP. 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. Tendency perturbations are now part of the 4dvar setup.	AlHa, JaKa, JaBa, KaHa, AlCa	t-code
E2.1.2	Further comparison of ALARO and AROME members in RMI-EPS will be done. Investigation of more extensive multiphysics in ALARO members to be investigated.	GeSm, MiVa	Non-t-code
E2.1.3	SPP (Stochastically perturbed parameterizations) will be further developed and tested for inclusion in CY43h2, by adding more parameters to the scheme and adjusting individually the parameter pdf's. The SPG pattern generator will be further tested. Combine with SPPT. Tendency diagnostics will be further developed as it offers a very detailed insight into the differences between different perturbations methods. Sensitivity studies in the Arctic using MUSC will be carried out (ext).	UlAn, ILF, SvdV, TeVa, WdR	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.1.1	AlHa	CY48-49?	2021
E2.1.3	UlAn	CY47 - CY43h2	2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.1.2	GeSm	HarmonEPS configuration test (namelist changes)	End 2019 ???

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	2
JaBa	Jan Barkmeijer	KNMI Netherlands	?
ILF, RoRa	Inger-Lise Frogner, Roger Randriamampianina	MET Norway	ext, ext
JeBo	Jelena Bojarova	SMHI Sweden	2

WP objectives

EDA will be developed further in 2020. LETKF, EDA 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.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.2.1	Optimize the EDA scheme with respect to the uncertainties of both observation and background. Continue to test inflation of EDA with the aim to reduce PertAna perturbations, or even to make them obsolete. It is seen that PertAna introduces noise in the first few hours of the forecast, due to imbalances in the perturbed fields.	ILF, RoRa	Non-t-code
E2.2.2	Compare ensemble performance with different types of initial conditions perturbations within variational or hybrid ensemble variational data assimilation framework : EDA, LETKF, forcing perturbations and BRAND perturbations. Upgrade the existing LETKF algorithm (cy43) with the new developments in HARMON-EPS (SPP, BCs and ICs Spread Increments, etc...). Special attention to the comparison with EDA performance. Explore the multi-model approach with LETKF.	JeBo, PaEs	Non-t-code
E2.2.3	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, JeBo	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.2.3	JaBa	?	End 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.2.1	ILF and RoRa	HarmonEPS configuration test	End 2020
E2.2.2	JeBo	optimal configuration of the variational EPS system	End 2020

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
HeFe	Henrik Feddersen	DMI Denmark	1.5
JdV	John de Vries	KNMI Netherlands	1
AnSi, HaMc, RaGr	Andrew Singleton (2), Harold McInnes (7), Rafael Grote (ext)	MET Norway	9
DaYa, JeMo	Daniel Yazgi (2), Jennie Molinder (ext)	SMHI Sweden	2
GeSm	Geert Smet	RMI Belgium	1

WP objectives

A priority in 2020 will be to study the soil moisture perturbations as they can lead to drying in some cases. Refine the surface perturbations and make them more realistic. 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	Study the soil moisture perturbations as it can lead to a drying in some cases. Test different spatial scales depending on the parameter, this work will continue in 2020. Uncertainties in vegetation fraction and leaf area index may depend on both vegetation type and season and so different perturbations could be applied dependent on those factors. Work on more sophisticated SST perturbations, to introduce perturbations where the uncertainty is believed to be largest (eg in sharp gradients of SST and sea ice) will continue, and also perturbations to snow albedo.	AnSi, HeFe, GeSm, JeMo, HaMc	t-code
E2.3.2	Surface physics: Continue study of perturbations in momentum, heat and moisture flux parameterizations in the context of SURFEX8.1. 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
E2.3.3	Towards consistent surface and upper-air surface perturbations, in connection with development of surface EnKF scheme (see SU1)	JeBo	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.3.1	HaMc	CY48-49?	2021
E2.3.2	AnSi	CY48-49?	2021
E2.3.3	JeBo	CY48-49?	2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.3.1	HaMc	HarmonEPS configuration test (for spatial scale testing)	2020

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
OlVi, ILF	Ole Vignes (0.5), Inger-Lise Frogner (0.5)	MET Norway	1
UlAn	Ulf Andrae	SMHI Sweden	0.5
HeFe	Henrik Feddersen	DMI Denmark	1.5

WP objectives

An important task in 2020 will be to study if humidity perturbations need to revised in order to reduce unrealistically dry conditions in some members.
Optimize use of ENS boundaries

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.4.1	SLAF and random field perturbations have shown good performance as LBCs and initial perturbations at approximately the same level ac IFS ENS. Study if this is due to non-optimal use of IFS ENS perturbations. Test possibility to improve ensemble spread by inflation.	HeFe	non t-code
E2.4.2	When nesting in ENS we see a higher error growth than when using SLAF (which is based on high res). One possibility could be to add the ENS perturbations on top of high res to reduce the error growth. This could however result in unblanced perturbation fields and in turn induce noise and spinup problems. This will be investigated in MEPS.	OlVi, UlAn, ILF	non t-code
E2.4.3	The humidity perturbations will be studied closer and we will investigate methods that don't lead to unrealistic dry conditions.	HeFe, OlVi	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 2020
E2.4.2	OlVi	configuration	2020
E2.4.3	HeFe	configuration	2020

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
OlVi, ILF	Ole Vignes (0.5), Inger-Lise Frogner (1)	MET Norway	1.5
UlAn	Ulf Andrae (1.5)	SMHI Sweden	1.5

WP objectives

Provide continuous support for the implementation of new HarmonEPS developments. Make common setup for continious running of HarmonEPS (like in COMEPS and in CMEPS).
The SPP approach perturbing uncertain parameters, will be an important task also in 2020.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.5.1	Develop SPP code further and optimize for operational use	UlAn, ILF	t-code
E2.5.2	Common setup for continious running of HarmonEPS	UlAn	
E2.5.3	Where needed, introduce system changes to support required HarmonEPS development.	OlVi, UlAn	non-t-code
E.2.5.4	Implement SPG in new cycle	OlVi	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.5.1	UlAn	CY47t1	2020
E2.5.4	OlVi	CY47t1 ? CY48-49?	2020?

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.5.2	UlAn	Configuration	2020
E2.5.3	OlVi, UlAn	Support	Cont.

ALADIN/HIRLAM/LACE WorkPackage description : E3

WP number	Name of WP
E3	Development, maintenance and operation of convection-permitting ensembles for LACE
WP main editor	**Clemens Wastl**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
NeHu	New Hungary team	OMSZ Hungary	5
ReSu	Reka Suga	OMSZ Hungary	2
KJR	Katalin Javorne Radnoczi	OMSZ Hungary	2
ChWi	Christoph Wittman	ZAMG Austria	2
ClWa	Clemens Wastl	ZAMG Austria	6
FlWe	Florian Weidle	ZAMG Austria	1.5
EnKe	Endi Keresturi	DHMZ Croatia	2

WP objectives

Development, maintenance and operation 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	Optimize settings of new random number generator (SPG) for convection-permitting ensemble at OMSZ. Work on tapering function	NeHu, ReSu	non-t-code
E3.2	Testing and optimization of supersaturation check for convection-permitting ensemble at OMSZ.	ReSu	t-code
E3.3	Optimization of different approaches in stochastic phyiscs (e.g. implementation of SPG pattern generator, tests for flow dependent pattern generator), testing of new observations in C-LAEF (ModeS, GNSS).	ClWa (5), NeHu	t-code
E3.4	Perform the “cheap” parallel experiments with lagged convection-permitting ensemble system formed by several deterministic AROME runs (RUC).	FlWe (1), ChWi (1), EnKe (2)	non-t-code
E3.5	Optimization and tuning of operational AROME based EPS system C-LAEF at ECMWF HPC.	FlWe (0.5), ChWi (0.5), ClWa (1)	non-t-code
E3.6	Continuous optimization and tuning of convection-permitting ensemble system on new HPC at OMSZ.	NeHu, KJR	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
E3.2	ReSu	CY40T1	2020
E3.3	ClWa, ChWi	CY40T1	2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E3.1	NeHU	feasibility study	2020
E3.4	ClWa, ChWi	scripts, verification results	2020
E3.5	FlWe, ChWi, ClWa	scripts, validation, C-LAEF operation at ECMWF HPC	2020
E3.6	KJR, NeHU	scripts, validation, AROME-EPS operation at OMSZ HPC	2020

ALADIN/HIRLAM/LACE WorkPackage description : E4

WP number	Name of WP
E4	Development, maintenance and operation of LAEF
WP main editor	**Clemens Wastl**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
SiTa	Simona Tascu	Meteo Romania	2
MaBe	Martin Belluš	SHMU Slovakia	7
MaIm	Martin Imrišek	SHMU Slovakia	1
IrOd	Iris Odak Plenković	DHMZ Croatia	4
EnKe	Endi Keresturi	DHMZ Croatia	1
NeHu	New Hungarian team	OMSZ Hungary	1

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 HPCF. 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	Implementation of new random number generator (SPG) suitable for LAM EPS environment in ALADIN-LAEF 5km	MaBe, NeHu	t-code
E4.2	Investigate the possibilities of stochastic perturbation of luxes instead of tendencies. This should be beneficial with respect to the energy balance preservation in perturbed models.	MaBe, MaIm	t-code
E4.3	Preparation of flow-dependent B-matrix using the ALADIN-LAEF 5km operational outputs.	MaBe, MaIm	non-t-code
E4.4	Creation of new ALADIN-LAEF probabilistic products to meet the different users requirements	MaBe, SiTa, IrOd (2), EnKe(1)	non-t-code
E4.5	Operational implementation of ALADIN-LAEF 5km Phase II configuration involving ENS BlendVar to improve the simulation of upper-air ICs uncertainty	MaBe	non-t-code
E4.6	Continuation work on analog-based post-processing method to improve the point forecast of high-resolution wind field. Investigate the possibility to use such a method for the ensemble of other surface parameters like T2m or RH2m.	MaBe, IrOD (2)	non-t-code
E4.7	Investigate ways for an ensemble forecasting with AROME-MAROC	SiSb	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
E4.1	NeHU, MaBe	CY40T1	2020
E4.2	MaBe	CY40T1	2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E4.3	MaBe, MaIm	scripts, reports, evaluation study	2020
E4.4	MaBe, SiTa	scripts, different probabilistic products	2020
E4.5	MaBe	Python and Perl scripts, functional ALADIN-LAEF operation at ECMWF	2020
E4.6	MaBe	report, scientific study	2019
E4.7	SiSb	report, scientific study	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
DaQu	David Quintero	AEMET Spain	1
KiWh, MaSc	Kirien Whan (2), Maurice Schmeits (1)	KNMI Netherlands	3
JBB	John Bjørnar Bremnes	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 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. During the last few years, advances have been made on several issues. More advanced methods like random forest, gradient boosting, and lately also neural networks have been applied and show promising results. Features derived from digital elevation models and land cover data have been created and can be used to partly explain spatial variations in the model error. Low quality measurements from private networks have increased the number of measurements extremely and proved useful, especially in otherwise sparse regions. The main challenge is to combine all of these; the computational aspects are of particular concern. More work is therefore needed.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E6.1	Apply recent and more flexible calibration methods that ideally are able to utilize all available input data with the overall aim of making calibrated forecasts at any point. The methods should be adapted so that training on very large data sets and prediction at millions of grid points is feasible in operational environments.	JBB, KiWh, MaSc, ThNi	Non-t-code
E6.2	Extend calibration to more parameters (clouds, visibility and/or wind gusts). At KNMI a new 3-year Harmonie CY40 reforecasting dataset will be used, because the KEPS archive is too short yet for calibrating forecasts of rare events.	JBB, KiWh, DaQu	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E6.1	JBB	Calibration code	2020
E6.2	JBB	Calibration code	2020

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	0.25
AlDe	Alex Deckmyn	RMI Belgium	2
AnSi	Andrew Singleton	MET Norway	2
ChZi	Christoph Zingerle	ZAMG Austria	1

WP objectives

HARP (Hirlam-Aladin R-package) is a common initiative dedicated to the development of verification tools in the Hirlam and Aladin consortia. A first toolbox for EPS (HARP-v1, 2015) and spatial verification (HARP-v2, 2017, including an update of EPS-verification) was established based on 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. Current work is inspired by the decision to change philosphy: "**harp**" will no longer be based on R-scripts, but will come as a number of installable R-packages for in/output, point (incl. EPS) and spatial verification and visualization. The goal is to provide these R-packes to work with tidy data together with examples and tutorials on the web as well as in workshops.

Continuous assessment, improvement and (where needed) extension of the EPS, point and spatial verification methods and tools will take place according to user demand in 2020 and beyond. With the advent and successive extension of deterministic point-verification functionalities in "harp", the aim is to eventually replace the existing deterministic verification packages used within ALADIN and HIRLAM in the coming years. A frequent demand of users for more documentation was followed with a User-Guide, a number of How-to's and examples using real data. However, documentation and support for users need to be extended. In addition it is planned to prepare and distribute tutorials and hands-on exercises in the form of webinars and workshops to a greater extend. Furthermore, as a consequence of the change to R-packages and the re-shape of the harp structure, work on harp will still continue into the coming years, as there will be updates and new functionalities (e.g. more verification methods, data from different sources, ...) in the "harp" specific R-packages. It is planned to update the scripts and configuration so it can be run using R only or as a standalone container on operational computing environments. It is also 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	Documentation of "harp" will be further extended. Up to date hands-on examples and tutorials, available online and in workshops. It is necessary to explain harp to the users starting from installation, followed by the use of verification measures and finally explaining visualization tools.	AlDe, ChZi, BHS	documentation, code
QA1.2	Continuing work on "harp" will focus to the successive extension of deterministic point verification (incl. EPS) and spatial tools and the use of different spatial observational data sources. Furthermore there will be efforts taken to make use of ECMWF analysis and the treatment of combined probabilities in EPS verification.	AlDe, ChZi, BHS	code
QA1.3	Implementation in harp 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, ChZi, BHS	code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
QA1.1	AlDe, ChZi	Extended documentation, examples and tutorials will be available and updated continuously.	2020
QA1.2	AlDe, ChZi	Code update for harp, tools for deterministic, EPS and spatial verification are available. They are successively integrated in the existing code v3.	Spring 2020
QA1.3	AlDe	Standalone containers with working versions of harp for installation on operational environments.	Beginning of 2020

QA1.4	AlDe, 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	**Bent Hansen Sass, Christoph Zingerle, Joël Stein, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
BeSa, HeFe	Bent Hansen Sass, Henrik Feddersen (1.75, 3)	DMI Denmark	4.75
GeGe,PiWa	Gertie Geertsema (2.25) , Ping Wang (2)	KNMI Netherlands	4.25
AnSi, MoKo	Andrew Singleton, Morten Køltzow (1, 0,5)	MET Norway	1.5
AlDe	Alex Deckmyn	RMI Belgium	1
JoSt, MaJe, FaSt	Joël Stein, Marine Jeoffrion, Fabien Stoop : DirOP/COMPAS	Météo-France	5
DaYa	Daniel Yazgi	SMHI Sweden	2
AkJo	Åke Johansson	SMHI Sweden	2
ChZi	Christoph Zingerle	ZAMG Austria	1

WP objectives

Research and development efforts focus on the three canonical system configurations (CSC's) which together make up the shared A-H System: Arome-France, Alaro-Cz and Harmonie-Arome. This work package concerns the development, validation and preparation of new verification methods for future use in the context of CSCs. New developments will potentially benefit all CSCs. - Existing EPS-point verification methods are not sufficient to grasp forecast quality of these systems in detail, especially when it comes to the problem of verifying different processes in clouds, convection and precipitation formation. In addition, density of standard meteorological observation networks, ground based or based on radiosondes, is far too low to represent the scale of convection permitting models or EPS's.
High resolution analysis and remote sensing observations (radar and satellite data) can provide important information on the 3D-structure of the atmosphere. However, each of these data sources has its limitations and their use in verification of convection-permitting models or ensembles is limited to specific features of the atmosphere. A focal point in the development of new verification techniques will be the availability of information about clouds, precipitation and convection from satellite and radar data. The existing spatial verification methods developed for deterministic models will be extended or adopted to high-resolution EPS systems in a number of steps (tasks QA2.1, 2.2 and 2.4). One simple approach to gain verification information in data sparse areas would be to verify EPS against analyses of deterministic models (e.g. ECMWF) (QA2.3). Score cards for deterministic models have been developed in the past years in CONTRALL (Météo-France) and in HARP to provide a quick overview of forecast quality. They will be extended with new scores, e.g. considering spatial and ensemble verification (QA2.5). Theoretical studies to understand the limitations of currently used (skill assessment of) ensemble prediction systems will be continued (QA2.6). In QA2.7 verification methods for probabilistic forecasts of high-impact, rare events are developed in CONTRALL and HARP. Results will be used to develop an associated guidance to duty forecasters. Finally, the development of a tool to generate MSG simulated SEVIRI images is described in QA2.8. New neighborhood-based methods are applied to ensemble forecasts to introduce some spatial tolerance in the computation of probabilistic scores. This also opens a new way to compare deterministic and probabilistic forecasts in QA.2.9.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
QA2.1	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
QA2.2	As an outcome of QA2.1 and previous analysis of available data a good knowledge of methods and data 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 provide a deeper insight into the ability of the model/EPS system to represent the 3-D state of the atmosphere and b) the processes determining cloud, convection and precipitation formation.	ChZi, AlDe	code
QA2.3	Include new metrics to characterize forecast errors both in space and time relative to ECMWF or HARMONIE analysis (HeFe, BeSa, AlDe). Finalize development of a spatial verification scheme (BeSa) investigating the analyzed and forecasted spatial structure of local extremes. Transfer developments to HARP for operational use (Hefe,Besa,AlDe).	HeFe, BeSa, AlDe	Develop and test code, document results (common code for HIRLAM and ALADIN)
QA2.4	Extend appropriate spatial verification techniques towards use in EPS. Use spatial verification (FSS) to determine upscaling/ neighbourhood radius. Compare upscaling and neighbourhood methods. (New results from QA2.1 and QA2.2 will be used when relevant)	AnSi, HeFe,BeSa, DaYa	Develop and test code, document results (common code)
QA2.5	Extend score cards to new verification parameters, e.g. mixing height, and/or measures for spatial verification and probabilistic verification.	MoKo, GeGe, JoSt, MaJe, FaSt	Scripts/code (common code for HIRLAM and ALADIN) and associated results of new developments
QA2.6	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.	AkJo	Code and reports documenting properties and limitations of current systems

QA2.7	Verification methods for probabilistic forecasts of high-impact, rare events and use of verification results to guide forecasters, e.g. above which forecast probability (possibly upscaled) should a forecaster issue a warning in order to expect a desired balance between hits, misses and false alarms. ? Other options include use of quantiles.	HeFe, JoSt, MaJe, FaSt	Methodology,code and results guiding forecasters' probabilistic treatment of high-impact weather.
QA2.8	Design, implementation and validation of tool to generate MSG SEVIRI simulated radiance data	PiWa	Code, user documentation, validation study
QA2.9	New neigborhood-based methods are applied to the verification of ensemble forecasts to allow the comparison of deterministic and ensemble forecasts	JoSt, MaJe, FaSt	Code, validation study in a peer-reviewed publication

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
QA2.1	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.	?
QA2.2	ChZi, AlDe	Prototype code to be implemented in HARP for spatial-EPS verification (Q1.6)	?
QA2.3	HeFe, BeSa, AlDe	Develop and test code, document results (common code for HIRLAM and ALADIN)	Dec 2020
QA2.4	AnSi, HeFe	Develop and test code, document results (common code for HIRLAM-and ALADIN)	Dec 2020
QA2.5	MoKo, GeGe, JoSt, MaJe, FaSt	scripts/code (common for HIRLAM-ALADIN) and results	Dec 2020 ?
QA2.6	AkJo	Code and reports documenting properties and limitations of current systems	Dec 2020 ?
QA2.7	HeFe, JoSt, Maje, FaSt	Methodology,code and results guiding forecasters' probabilistic treatment of high-impact weather.	Dec 2020 ?
QA2.8	PiWa	Code and Validation	?
QA2.9	JoSt, MaJe, FaSt	publication in international review	in 2020

ALADIN/HIRLAM/LACE WorkPackage description : QA3

WP number	Name of WP
QA3	Quality assessment of new cycles and alleviation of model weaknesses
WP main editor	**Bent Hansen Sass, Joël Stein, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
GeMo	Gema Morales	AEMET Spain	4
BeSa,KrNi,XiYa	Bent Hansen Sass,Kristian Pagh Nielsen, Xioahua Yang (3.5,1.0,0.25)	DMI Denmark	4.75
MaKa	Markku Kangas	FMI Finland	2
SaTi, WiRo,ST,	Sander Tijm, Wim de Rooy (1.5, 1.0)	KNMI Netherlands	2.5
EmGl	Emily Gleeson (1)	MET Eireann	1
RoRa	Roger Randriamampianina	MET Norway	0.25
KaIv,PaSa	Karl-Ivar Ivarsson (2), Patrick Samuelsson (0.25)	SMHI Sweden	2.25
SiTh	Sigurdur Thorsteinsson	IMO Iceland	0.25
MaJe, FaSt,JMVi, FrPo,YaPr	Marine Jeoffrion, Fabien Stoop, Jean-Marie Willemet, Francis Pouponneau, Yann Prigent : DirOP/COMPAS	Météo-France	18

WP objectives

Quality Assurance is a vital part of the development process of new model cycles for operational use. This work package describes tasks connected to the canonical system configurations (CSCs), namly Arome-France, Alaro-Cz and Harmonie-Arome. The different tasks may reflect that different cycles are being worked on in the evaluation proces for operational use even if the common code all follow common phasings of the IFS together with ECMWF: A combined work package can potentially facilitate fruitful communication between the different groups working with verification and validation of the CSCs - **For Harmonie-Arome:** Weaknesses of the model system are investigated on the basis of detailed observational studies, analysis of output from verification systems and from interaction with users of harmonie-Arome, mainly in the Met-Institutes. The goal of the first task (QA3.1) is to diagnose model weaknesses ,partly based on objective verification of operational systems, e.g. from the RCR centres. Additional information on model weaknesses and limitations will be obtained through communication with users of Harmonie-Arome. A list of TOP 10 forecasting issues will be maintained. The overall goal is to make sure that the Reference CSC remains an ambitious state-of-the-art NWP system. In order to make realistic upgrades to the model system it is important to diagnose model deficiencies of different origin, e.g. if model limitations are linked mainly to a process description in the free atmosphere or to surface processes or to limitations in the data-assimilation. In this context challenges arise since we know that a mutual interaction occurs between all these branches of the model system.

For the atmosphere the prediction of humidity and water species is considered particularly important since these parameters are vital in the context of cloud, radiation and precipitation. The related processes affecting humidity and hydrometeors, e.g. turbulence, convection, microphysics and dynamics are critically important. These processes are closely interrelated. The development and tests to upgrade the physical parameterizations are contained in the physics work packages, e.g. PH2 and PH4. The developed upgrades of these packages will be verified in the present work package, e.g. from parallel runs in operational environments. Relevant verification tools will be used ,e.g. new verification schemes developed in QA1 (HARP) and QA2 (new verification methods). The complex issue of verifying 4D-clouds (verification in space and time) will be partly done in PH2.2 (verification of atmospheric cloud fields in connection with CRIME project) . However developments will also be done in the context of HARP. T work and tests planned for atmospheric processes is summarized in task QA3.
2 -
For the surface the work is defined in QA3.3. A complication occurs that the surface variables are affected by processes in the atmosphere e.g. in the form of fluxes of precipitation, radiation, sensible plus latent heat and momentum. Hence deficiencies, e.g. biases in 2m temperature and humidity are not only dictated by the surface scheme including physiographic data. In order to get an improved framework for work on the surface deficiencies the present plan includes work to verify surface fluxes arising from the atmosphere by comparisons with observations. Efforts are strengthened to compare solar- and infrared radiation with surface observations and satellite derived products. Data from meteorological masts will also be used for this. The impact of model upgrades will be studied. Also it is suggested to investigate whether the meteorological formulas used for deducing near surface parameters e.g. 2m temperature can be improved for the stable boundary layer. - - - For the data-assimilation the issue of model spinup has been an important one in the past. The properties of new data-assimilation schemes that have become available should be assessed, e.g. with regard to model spinup. New methods include nudging for humidity and clouds as well as 4D-VAR (see QA3.4) -Finally, in task QA3.5 a summary report related with Harmonie-Arome improvements in 2020 is produced. The impacts of current year's initiatives to alleviate the TOP 10 modelling issues mentioned in task QA3.1 should be mentioned.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
QA3.1	a) Analyze results of routine verification from HARMONIE-AROME, e.g. from RCR centres (BeSa,GeMo). Maintain multiyear time series to monitor trends in quality of operational performance (BeSa). Maintain infrastructure to do so, excluding HARP (XiYa;GeMo). - b) Communication with users on identified model deficiencies, to be documented in hirlam.org. A list of key forecasting issues identified with users will be maintained and a list of top scientific priorities will be adjusted in the work plan to be consistent with the list of identified key forecasting issues (BeSa).	BeSa, GeMo,XiYa, MaSc,KiWh	Reports, e.g. on hirlam.org, (code updates if needed)
QA3.2	ATMOSPHERE: Verify impact of developed updates in PH2 package e.g. from paralel test runs in operational environments. If feasible test further updates to alleviate diagnosed model weaknesses a) Turbulence and convection: (SaTi , WiRo) - b) Cloud parameterization: Improved cloud parameterization (WiRo, KaIv). - c) Microphysics: (SaTi, KaIv).. - d) Precipitation skill: Carry out study to evaluate precipitation skill in Harmonie-Arome, i.e. accuracy in space and time,e.g.using spatial verification schemes and tool(s) to investigate systematic errors in time. The performance of new cycle will be compared with earlier versions and ECMWF forecasts. Precipitation analyses will be needed for this. (GeMo, BeSa) - e) Alleviation of Fog prediction problems: Document work done (SaTi,KaIv).	SaTi, WiRo, KaIv,GeMo, BeSa	GRIB files with results + verification + source code

QA3.3	SURFACE: Intercompare Harmonie-Arome against mast profiles for European sites. Write a report to illustrate model characteristics of the most recent cycle compared with older cycles , e.g. compared over several years. (MaKa). b) Verify surface solar- and infrared radiation from Harmonie-Arome against surface station networks measuring these fluxes (KrNi, EmGl). c) Verify model global surface solar radiation against satellite data based on MSG-CPP from KNMI (KrNi). - d) Implement and test modified diagnostic formulas for the stable boundary layer, e.g. according to Sass and Nielsen , HIRLAM Newsletter no. 54, verify and prepare code for new cycle if successful (SiTh).	MaKa,KrNi,EmGl,SiTh	Verification , report(s) + source code, GRIB-files with results
QA3.4	DATA-ASSIMILATION: Investigate impact of recent data-assimilation techniques (e.g. cloud inititialization and 4DVAR) on model spinup. Possibly implement upgrades. For cloud initialization this includes attention to selective removal of fog (RoRa and data-assimilation team) .	RoRa and data-assimilation team	reporting impacts including verification results, possibly code with updates
QA3.5	A report is prepared to document the impacts of upgrades during 2020 and the current year's initiatives to alleviate the TOP 10 modelling issues (BeSa, SaTi, RoRa, PaSa)	SaTi, BeSa, RoRa,PaSa	Documentation (report)
QA3.6	AROME-France (and ARPEGE): all the changes in the operational models are evaluated by a comparison of the scores during a verfication period of some months in order to show a significant positive impact of the new version. During this period, a subjective comparison is also organized with operational forecasters and their results are also taken into account in the final choice.	MaJe, FaSt,JMVi, FrPo, YaPr	Documentation (report)

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
QA3.1	BeSa,GeMo,XiYa	Reports, e.g. on hirlam. org, (code updates if needed)	3 - 4 reports in 2020
QA3.2	SaTi, WiRo, KaIv,GeMo,BeSa	GRIB files with results + verification + source code	December 2020
QA3.3	MaKa,KrNi,EmGl,SiTh	Verification , report(s) + source code, GRIB-files with results	December 2020
QA3.4	RoRa and data-assimilation team	GRIB files with results, verification, code with updates	December 2020
QA3.5	SaTi, BeSa, RoRa,PaSa	Report(s) documenting results of initiatives and new cycles	December 2020
QA3.6	MaJe, FaSt,JMVi, FrPo,YaPr	E-suite report	December 2019 & December 2020

ALADIN/HIRLAM/LACE WorkPackage description : SY1

WP number	Name of WP
SY1	Code optimization
WP main editor	**Daniel Santos, Ryad El Khatib**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
DaSa	Daniel Santos	AEMET Spain	2
JWP	Jacob Weisman Poulsen	DMI Denmark	0.25
BeUl	Bert van Ulft	KNMI Netherlands	1
OlVi	Ole Vignes	MET Norway	1
NiSo	Niko Sokka	FMI Finland	2
PhMa, REK, YoZh	Philippe Marguinaud, Ryad El Khatib	Météo-France	5
OlSp	Oldrich Spaniel	SHMU Slovakia	1

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. 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. 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.
HIRLAM has approached the Barcelona Supercomputing Center to engage in a close collaboration on assessing and optimizing the IFS/AAAH LAM code performance and scalability. The aim is to start this with a HIRLAM-funded effort by BSC to make a basic code performance and scalability assessment, followed by a deeper (joint) investigation of several aspects such as the OpenMP implementation and the potential of single or mixed versus double precision. It is also intended that BSC will make available its basic performance and scalability assessment tools to the ALADIN-HIRLAM community and provide training to system experts in the use of these tools in benchmarking and optimization efforts.

Descriptions of tasks

Task	Description	Participant abbrev.h	Type of deliverablei
SY1.1	Continue the work on Fullpos-2 (in relation with OOPS actions)	REK	T-code
SY1.2	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?
SY 1.3	Explore machine learning techniques: Radiation scheme on GPUs (ESCAPE 2 project)	KPN ?	Non-t-code
SY 1.4	4DVar profilling and optimization for operational uses. Extension zone redefinition	OlVi, NiGu, NiSo	
SY1.5	Single vs double vs mixed precision studies for Harmonie CMC	OlVi	Non-t-code

SY1.6	Coordination and collaboration with Barcelona Supercomputer Center in the study about the efficient use of the computational resources. Basic code performance and scalability assessment will require: - Prepare two model configurations and BSC Tools for ECMWF HPC - Basic analysis of HARMONIE-AROME and Data assimilation execution on ECMWF HPC. - Basic MPI/OpenMP performance analysis on ECMWF HPC. - Training courses on BSC tools and analysis methods. - Documentation about the process and results (probably ends during 2019) Also a possible extension of some tasks or include new ones like: - Extending the profiling analysis of HARMONIE-AROME and data assimilation, including a specific study for OpenMP/MPI implementation and suggesting some possible optimizations. - Including BSC HPC (MareNostrun4) for the analysis and deployment of the model using BSC Tools, all the results on ECMWF HPC are obtained on MN4 too - Extending the mixed precision study, not only analyzing the present implementation, but also using out methodology to provide a mixed precision implementation where the simulation results are similar to the double precision version and the computational performance better. - Extending the OpenMP/MPI implementation to ensure not only an analysis of the OpenMP/MPI performance, but also ensure that some optimizations are included and a new approach is tested to improve the computational performance and take advantage of the OpenMP paradigm. - Testing more than two configurations on ECMWF HPC and MN4	DaSa, JWP, BeUl BSC team	Non-t-code
SY1.7	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	non-t-code
SY1.8	Further studies with single-precision versions of the NWP codes for the forecast models	PhMa, other GMAP staff tbd, OlSp	t-code

t-code deliverables

Task	Responsible	Cycle	Time
SY1.2	REK	CY45T1, CY46T1	2017-2018
SY1.6	DaSa	CY46T1, CY47T!	2018-2019
SY1.8	PhMa	CY43T2, CY46T1?	2016-2018

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SY1.4, SY1.5	OlVi	Report and fixes	2020
SY1.6	DaSa	Reports and code optimization options	2020

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	Daniel Santos (3), Angeles Hernandez (2)	AEMET Spain	5
NiSo	Niko Sokka	FMI Finland	2
BeUl	Bert van Ulft	KNMI Netherlands	2
EoWh	Eoin Whelan	MET Eireann	2
OlVi	Ole Vignes	MET Norway	1
UlAn	Ulf Andrae	SMHI Sweden	2

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 CSC 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
SY 2.1	Consult Hirlam services on agreements to run a Harmonie RCR	DaSa	Non-t-code
SY 2.2	Implementation, monitoring, pre-release validation and testing, release and maintenance of non-CSC parts of the Reference System; support of the Reference system at one or more operational platforms.	DaSa, UlAn, OlVi, TrAs, NiSo, EoWh, HeFe, ToMo, BeUl	Non-t-code
SY 2.3	Test injection of observation data at ECMWF and operational platforms running RCR	DaSa, UlAa, OlVi, NiSo	Non-t-code
SY 2.4	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
SY 2.5	Implement GRIB2 eficient encoding of atmospheric and surface fields. Document GRIB2 outputs.	UlAn, AnHe, DaSa	Non-t-code
SY 2.6	Continued ECFLOW support and increased capabilities	DaSa, OlVi, AnHe	Non-t-code
SY 2.7	Webbinars on GIT use and working practices. Stablish a GIT GUI.	KaSa, DaSa	Non-t-code
SY 2.8	Arrange training in Harmonie and its components for newcomers in 2020.	DaSa	Non-t-code
SY 2.9	Design and implement mitraillete tests for Harmonie	NiSo, DaDe	Non-t-code
SY 2.10	Move postprocessed fields from gl to fullpos, like visibility, cape...	UlAn	t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SY 2.2	DaSa	Code, Scripts	2020
SY 2.5	UlAn	Code, Documentation	2020
SY 2.6	OlVi	Scripts	2020

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(2), Angeles Hernandez(1)	AEMET Spain	3
KaSa	Kai Sattler	DMI Denmark	3
PaMa	Paulo Medeiros	SMHI Sweden	2
NiSo	Niko Sokka	FMI Finland	2.5
AlDe	Alex Deckmyn	RMI Belgium	0.5
RoSt, YuBa	Roel Stappers (efforts listed under COM1.2), Yurii Batrak (1)	Met Norway	1

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 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. Explore pysuite and pyflow	DaSa, PaMa, BeUl	Non t-code
SY3.2	Interaction on new scripting system design based on the outcomes of strategy meeting	DaSa, AlDe	Non t-code
SY3.3	Develop and maintain a more user-friendly system setup for forecast model experiments for short-range, nowcasting, reanalysis and long climate runs.	AnHe, RoSt, NiSo	Non t-code
SY3.4	Implement the possibility of sub hourly cycling and consistent timestamps.	NiSo	Non t-code
SY3.4	Prototype generation of “build task” to improve code compilation and as proof of concept. Include cmake as optional compilation method. Possible use of ecBuild	PaMa,BeUl, YuBa	Non t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SY3.1	DaSa	Report and Scripts	2020
SY3.5	DaSa	Scripts	2020

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, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
AE	Javier Calvo (1), Juan Simarro (3), Daniel Santos (1)	AEMET Spain	5
JuCe	Jure Cedilnik	ARSO Slovenia	1
PeSm	Petra Smolíková	CHMI Czech	1
MaHr	Mario Hrastinski	DHMZ Croatia	1
XiYa	Xiaohua Yang	DMI Denmark	1
JaWo, PiSe	Piotr Sekula	IMGW Poland	3
SaTi	Sander Tijm	KNMI Netherlands	1
MaNa	Marass Najla	Maroc Meteo	1
EmGl, CoCl	Emily Gleeson, Colm Clancy	MET Eireann	1.5
RaHo, SaAn, YaSe	Rachel Honnert, Salomé Antoine, Yann Seity : CNRM/GMAP	Météo-France	18
DiRi	Didier Ricard : CNRM/GMME	Météo-France	5
EsOl	Karl-Ivar Ivarsson	SMHI Sweden	1

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, the aim is to resume R&D efforts for AROME at 500m mesh size, and implement a test configuration for a research field campaign dedicated to the process and forecasting of fog. The field campaign is to take place in 2019-2020 in the South-West of France (SOFOG3D). Emphasis will be put on the evaluation of the microphysics schemes, with a focus on LIMA.
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.
Progress expected in the fields of our model dynamics (gridpoint version of SI, new sets of [d, W] variables in NH) may provide new possibilities for formulating improved versions of the turbulence schemes at hectometric resolution (use of gradients, representation of orography, bottom boundary condition etc.).

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
HR1.1	Determining the optimal configuration of high-resolution Harmonie-Arome (~1km) in dynamics, physics, data assimilation and ensembles.	XiYa, EsOl, BoBo, CoCl, SaTi, AE	report
HR1.2	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 and observations.	JuCe(1), BoBo, CoCl, XiYa, AE	report
HR1.3	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 and test the PC on demand option.	CoCl, AE	report
HR1.4	An update of the AROME-France 500m configuration, perhaps first near an airport, later for the field campaign dedicated to fog.	RaHo, SaAn, YaSe, MaNa	namelists
HR1.5	Establish a model setup that would run dynamical adaptation of wind using the latest export version and establish optimal tuning of dynamics and TOUCANS.		report, scripts, namelists, t-code ?

HR1.6	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) and what is the effect of single precision in combination with 90 levels?	CoCl	configuration
HR1.7	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
HR1.9	3D turbulence solution in the AROME/ARPEGE/IFS code structure: how to implement 3D effects including horizontal exchange. The approach that we'd like to try is to code the 2D effects in the physics grid point section of the code (besides the 1D vertical part). This will require to carefully analyze which additional data has to be provided to the physics (from other parts of the model data flow).	RaHo	report, t-code
HR1.10	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, RaHo	report, non-t-code
HR1.11	Redesign of the diffusion coefficient used in SLHD and being a monotonic function of the total flow deformation along the terrain-following vertical levels.	PeSm	report, non-t-code
HR1.12	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.	MaHr (1), PeSm	report, non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
HR1.5	MaTu		end 2018
HR1.9	RaHo		2020-2023

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
H1.1	XY, EO	report	
H1.2	tbd	report	
H1.3	CoCl, JS	report	
H1.4	GMAP staff	namelists	
H1.5	MaTu	report, namelist, scripts	
H1.6		configuration	
H1.7	tbd	report	
H1.9	RaHo	report, non-t-code	
H1.10	DiRi	report, non-t-code	
H1.11	MaHr, PeSm	report, non-t-code	
H1.12	MaHr (1), PeSm	report, non-t-code	