ALADIN/HIRLAM/LACE
Rolling Work Plan 2021

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 codes. The cooperation takes the form of joint scientific and technical model developments within this shared ALADIN-LACE-HIRLAM System (ALH). Research and development efforts focus on three so-called canonical system configurations (CSC's) based on canonical model configurations (CMCs) which together make up the shared ALH System: Arome(-France), Alaro and Harmonie-Arome. It is these canonical system 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. Since 2018, the activities within the ALADIN-LACE-HIRLAM cooperation have been described in a yearly jointly produced rolling work plan.

From 2021 onwards, ALADIN, LACE and HIRLAM will start a new joint consortium. In the process towards the joint consortium, new strategic objectives were defined and it was decided to extend the scope of the common activities from the CMC's to CSC's in a stepwise manner. Also, a new joint strategy has been prepared for the period 2021-2025.

This document represents the joint rolling work plan (RWP) for 2021, updated to the strategy 2021-2025. The main aim of the RWP is to provide clarity on the expected evolution of the common code in the course of one year time and somewhat ahead, 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 the management of the consortium, on code design and engineering, generation of new CSC code and subsequent maintenance, on general support for local implementations, troubleshooting, training and information exchange (chapter 1).
- 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 decided to define one single new strategic programme, on transversal software developments (SPTR), starting in 2021. Two earlier programmes, one on the scalability and efficiency of the dynamical core and one on providing a basic data assimilation setup for all members, will be incorporated in either the new SPTR programme or in one of the existing other work packages (see the bullet below). At a later stage, other programs may be introduced.
- Prospective R&D and/or operational-oriented activities which are carried out by a subgroup of members willing to invest resources in them. 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 3, 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 CSC codes, while others may represent more fundamental research, not providing short-term contributions to new code cycles. Furthermore, the work package description contains the information on the staff commitments for all areas and tasks, as proposed by the Members.

A summary of the planned evolution of the code is provided in the annexes 1 (timing of IFS/Arpege/LAM cycles) and 2 (content of recent and upcoming cycles).

1. Management, common code evolution and quality assurance, general coordination and support activities

1.1 Overview of the work packages on common activities

1.1.1 Management activities

As the new ALH management group will not be able to fully start its activities until after the first quarter of 2021, the work of the still existing ALADIN, LACE and HIRLAM management has been retained for the first quarter (in work packages MGMT1-3). Work package MGMT4 contains the planned work of the new ALH management group.

1.1.2 Common code design, generation, maintenance, and quality assurance activities

These are all the activities required to translate scientific developments in code suitable to enter the shared ALH system during phasing, to validate and maintain this code in scientific and technical sense, to ensure its quality and to provide general support for implementing new code cycles operationally. The RWP takes into account the day-to-day business of code evolution and quality assurance in the layout of today working practices (which are described in work package COM2.1). Furthermore, it describes the activities required for achieving the strategic longer-term goal of creating an improved process for code evolution (which are described in work package COM2.2).

1.1.3 General support activities

Three types of general support activities are described in the RWP:

- WP COM3.1: Support for maintenance and Partners' implementations of the common ALH System in the Member countries, mainly through the activities of the Coordinator for Networking activities.
- WP COM3.3: Training activities
- WP COM3.4: Activities supporting general information exchange, through attendance, local organization, and preparation of contributions to the All Staff Workshop and SRNWP/EWGLAM meetings

1.2 The expected evolution of the common code

1.2.1 T-cycles construction and porting to Members

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

The content and timing of a new code release depend on the nature of that release. The content of LAM code versions is being discussed between the LAM partners in various meetings and communication (MG meetings, e-mails in preparation of T-cycles, specific CSC system coordination etc.). So-called T-cycles in Toulouse are ALH 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 ALH representatives 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. CY48 is the base for CY48T1). The table in Annex 1 summarizes the timing of the forthcoming cycles, as agreed at the IFS/ARPEGE coordination meeting of fall 2020.

T-cycles receive LAM (limited area model) R&D contributions and can be technically evaluated mostly by sanity checks (so-called "mitraillette" for the forecast model configurations or the new under development "davaï" tool) 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. It is worth mentioning that with "davaï", components of data assimilation will be validated much earlier in the process. Validation of all components of a CSC (that also includes data assimilation and perturbation methods) will be done subsequently.

From CY48 onwards, "davaï" will be used for the assessment of contributions, initially together with mitraillette; but eventually "davaï" is expected to replace the mitraillette tool. Presently it can only be used within the Meteo-France infrastructure, but it is aimed to develop a more portable version, so that the tool can be ported to other platforms to permit remote testing of new components in the future.

Another type of code versions are those versions specifically prepared for promotion and installation with any Member. 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), based on T-cycles, are being defined and prepared for common operational use. H-cycles include fixes but also a fair amount of R&D developments, which are intended to be phased forward and submitted to future T-cycles. In the ALH strategy for 2021-2025, it is aimed to develop a more continuous and distributed phasing process, based on shared repositories. This development should make the present differences between T- and H-cycles increasingly irrelevant. The practical details of how "export versions" or "H-cycles" are being prepared will however still differ between the two groups of Members in the first years. Another aspect that will be considered is the transition from technical to meteorological quality assurance, where more coordinated efforts will be promoted throughout 2021-2025. Several specific steps are expected to trigger this increased coordination: the improved working methods on cycles, the steps towards a more common working environment (and semantics), the continued efforts on common developments of meteorological quality assurance tools, the common management structure per se. Eventually, it is intended to extend the scope of the common code assessment to include more components, initially data assimilation, and at later stages e.g. ensemble modelling and scripts.

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. Recent scientific and technical developments are explained in documentation, Newsletters and at regular Consortium workshops.

1.2.2 Additional information

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 about 7-8 FTE to phasing efforts per year. Staff from the ALADIN(-LACE) Members 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 effort 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. 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 ALH lead scientists but also System Experts..

In addition to the main NWP shared codes of the IFS-ARPEGE-LAM "galaxy", the CSCs 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. Ways to improve this situation are being considered.

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 WP COM2.1.

The thematic work package sheets in chapter 3 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.

2. Strategic (core) programmes

From 2018 until end 2020, there have been two strategic programmes within the Rolling Work Plan: (a) the Dynamics and scalability programme, aiming to address the question *"How should the dynamical core evolve so that also in the future the combination of high accuracy and computational efficiency can be guaranteed?"*; and (b) the Data assimilation programme, aiming to create and implement a basic data assimilation setup for all members. In the newly adopted ALH strategy 2021-2025, it was decided to (1) introduce a new strategic programme on Transversal software development (SPTR), (2) incorporate the activities in the Data assimilation programme as a new work package in the prospective data assimilation R&D activities, and (3) incorporate the activities from the Dynamics and Scalability programme partly into the new SPTR programme and partly in the existing prospective dynamics work packages.

2.1 Strategic programme on Transversal software developments

The new strategic programme on Transversal software developments, SPTR, is aiming to prepare our codes to function efficiently and in a maintainable manner on the computational hardware of the future. In view of the uncertain future evolution of the software infrastructures, the key element to achieve this is to follow the approach of separation of concerns, as explained in the ALH Strategy 2021-2025, in close cooperation with ECMWF's Scalability programme. The challenge is therefore to develop new layers of software that are capable of generating an efficient hardware-specific code, starting from the high-level abstract scientific code. For this purpose, the intention is to study and use the domain-specific language (DSL) approach that was adopted by the ECMWF.

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 approach followed in the new ALH strategy for developing a possible future dynamical core, one of the main tasks of this work package is to ensure that the Atlas framework will support our limited-area model configurations. Even though the introduction of Atlas in the IFS is not foreseen for the immediate future, LAM-awareness in Atlas has already been addressed by the ALH community in the past since its early design stage. The next step is to fully integrate the LAM features in the Atlas repository.

Thirdly, there is a need for flexibility in code components that perform calculations along a single dimension, by means of so-called "single column abstraction" (SCA) of these components. "Horizontal" dimensions, loop ordering and boundaries and of course the exact memory layout of the state variables are abstracted, so the SCA code itself only represents a compact form of the schemes or codes, with the "vertical" operations only. The approach which was originally developed for this in Switzerland and adopted later by ECMWF, called CLAW, will be studied and, if suitable, imported from them. To avoid future rewrites, CLAW will need to be adapted to Atlas at the same time as the existing representation of the state variables (GFL, GMV) needs to be made Atlas compatible. Dynamics developments on possible future alternatives to the present dynamical core (work packages DY2 and DY3) will strongly rely on the features of Atlas.

Ongoing activities of adapting recent cycles to existing and emerging technologies such as GPUs, and to optimize the code on existing familiar HPC platforms, are addressed in the SY1 work package.

3. Prospective R&D activities

3.1 Overview Atmospheric data assimilation

Presently, data assimilation in the operational suites of the members is still based on 3D-Var. While the 3D-Var system can still be improved in various ways (WP DA1), the focus is increasingly shifting towards the introduction of more advanced flow-dependent assimilation methods (WP DA2). In Harmonie CSC 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. Members 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.

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. Finally, WP DA8 describes the activities undertaken to implement a basic data assimilation system for all members who do not yet possess it.

3.2 Dynamics

The present dynamical core of all three CSC's is spectral, with semi-Lagrangian advection and semi-implicit time stepping. WP DY1 describes the relatively short-term studies which are done with the aim to improve the performance of this existing dynamical core, through advances in the treatment of lateral boundary conditions, time stepping, discretization and semi-Lagrangian advection. The remaining two work packages contain longer-term developments towards alternative future dynamical cores. WP DY2 is aiming at assessing the developments of a finite-volume-based grid-point dynamical core (FVM) which have been initiated at ECMWF, and their potential usefulness as a framework for a new LAM dynamical core. The focus in WP DY3 is to assess the feasibility of a grid-point solver for dealing with the implicit terms of our model equation.

3.3 Atmospheric physics parameterizations

The key difference between the three present CSCs 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 WP PH3 on Alaro. WP PH4 concerns the development, maintenance and use (for validation purposes) of the common 1D MUSC environment. WP PH5 aims to identify model post-processing output that is relevant to add to the common code for all CSCs, and make plans and preparations for developing and implementing such new common post-processing.
As a consequence of the new ALH strategy for 2021-2025, several new work packages have been added:

- WP PH6: study of the cloud-radiation-aerosol-microphysics interactions

- WP PH7: the development of new approaches for 3D-physics, required for modelling at very high spatial resolutions.
- WP PH8: assessment of the usefulness of applying machine learning techniques in physics parameterizations
- WP PH9: assessment of how the existing three main physics configurations (ALARO, Arome-France and Harmonie-Arome) can be made more interoperable
- WP PH10: study the options for developing more truly stochastic formulations for the physics parameterizations

3.4 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)

3.5 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 development of ensemble calibration and post-processing techniques (WP E6)
- the development of more user-oriented approaches to ensemble output and post-processing (WP E7)

3.6 Quality assessment and monitoring

The work in this area entails the following activities:

- The development of the HARP verification system (WP MQA1)
- The development of new verification methods methods for verification and quality control (WP MQA2)
- Quality assessment of new cycles and alleviation of model weaknesses (WP MQA3)

3.7 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)
- In the ALH strategy 2021-2025, the development and implementation of a more common working environment was seen to be of high priority. Elements of this common working environment will be designed in WP COM2.2. In WP SY4, practical choices will be explored for the actual implementation of these designs. Prototypes will be made for common repositories, for

a common testing environment based on the “davaï” tool developed at Meteo-France, for a common platform for technical information exchange which is well integrated with the multiple GIT repository infrastructure. Also, the options for converging towards a more common scripting system will be assessed.

3.8 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

Hereafter is a draft table of timing of recent and upcoming IFS/Arpege/LAM cycles. The timing of the next cycles will be further discussed with ECMWF by December 2020.

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*	*Version "bf.06" enables running the Arpege and Arome main configurations. Declared on 14 October 2020*	*several upgrades until bf.06*
	CY46R1		31 May 2018	Feb 2019	OOPS updates + science. Operational since 11 June 2019
CY47			Mid-February 2019	19 Aug 2019	Target joint cycle for baseline OOPS in Research mode
		CY47T0	End August 2019	3 September 2019	OOPS-MF prototype & array bound check
		CY47T1	10 October 2019	30 January 2020	MF aim was to wrap-up all changes from CY43T2_op2.
	CY47R1		July 2019	February 2020	
	CY47R2			Autumn 2020	Expected to become the porting cycle for Bologna. ***Note: this code not included in CY48 !***
CY48			6-10 Jan 2020	3 Sept 2020	
		CY48T1	Oct 2020	End of Feb 2021	Could be a base version for OOPS/3DEnVar in Arome-France ?
	CY48R1		Q3/2020 ?	Q4/2020 ?	Single precision runs in ENS
CY49			Spring 2021 ?		To be discussed
		CY49T1	?	?	Tbc in 2021
	CY49R1		Late 2021	2022	OOPS operational for 4D-VAR/IFS

Annex 2: Common cycles and preliminary content

(status of this list as of 2 October. 2020)

CY43T2_bf latest upgrades:

v09 was built on 28 June 2018:

- a few specific late fixes:
  - Fullpos/fpcorphy.F90 (R. Brozkova, R. El Khatib)
  - bator fix for HDF5 radar ODIM format (F. Guillaume)
  - changeset in Surfex/PGD codes in order to enable the handling of an E-zone in the native PGD file (A. Mary)
- this v09 became the base for the first Aladin export version

V10 as an incremental update of the Aladin export version, built on 27 February 2019 (input coordinated with LACE/ASCS and Aladin/ACNA)

v11 with additional changes prepared by Aladin and Hirlam partners, under coordination by ACNA and LACE ASC, released on 25 June 2020. NOTE: for the file "arpifs/op_obs/inv_refl1dstat.F90", please use version bf.10 (only active for radar DA)

CY46T1_bf:

Validation of Arpège and Arome applications (Arpège 4D-VAR, Arome 3D-VAR, EDA etc.) is ongoing based on CY46T1_bf. Several upgrades of the bugfix version have taken place, in order to add corrections found while validating DA as well as to catch up with the last operational Arpège/Arome versions (from CY43T2):

CY46T1_bf.04: match up with CY43T2_op4 and base version for a long run validation of Arpège 4D-VAR (2 month validation period in GMAP started with this version) [9 June 2020]

CY46T1_bf.05: 2 month-long Arpège 4D-VAR ran with accepted results + Arome 3D-VAR (actually using _bf.03+) and AEARP. [2 Sept 2020]

CY46T1_bf.06: fix for ISP, any other fix needed by other applications (eg PEARP, PEARO etc.). Update by end of Sept or beginning of Oct 2020.

CY46T1_bf can be considered for an export version.

CY48: January – April 2020 (EC/MF planned timing in beg. Of 2020). The timing was constrained by MF's change of HPC, which was planned to occur in spring 2020. Porting the operational NWP suites to the new (BULL-Sequana) HPC would then take place from March/April onwards. This timing originally was rather in-line with EC's planning for the move of their new HPC to Bologna (though delays for EC already were announced in late 2019).

With both the additional delays of the move of EC's Data Centre to Bologna (now 2021) and the delays in installing and migrating to the new HPC solution in MF (now targeted for end 2020), the actual final timing of CY48 got shifted into the summer period. The declaration eventually took place on 3 Sept 2020.

CY48T1: The build process is proposed to be in two stages:

1. Oct-Dec 2020 with a trial process of quasi-continuous integration of contributions,
2. and an extension for finalization steps in January-February 2021.
3. More precise timing and milestones will be presented to all main system coordinators and contributors.

Annex 3: Work packages and staff resources for 2021 (person/month)

Work package	Description	Resources (pm)
MNGT1	Management and ALADIN support activities	5.75
MNGT2	Management LACE	4.75
MNGT3	Management HIRLAM	15.25
MNGT4	NEW !!! Management ALH	63
COM2.1	Code generation and maintenance: ongoing process, tools already used	96.5
COM2.2	Code generation and maintenance: evolution of the work practices and environment	7.5
COM3.1	Maintenance and Partners' implementations of ALH system	120.25
COM3.3	Training (preparation, lectures, attendance)	4
COM3.4	NEW!!! Attendance and preparation of ASW & EWGLAM	21
SPTR1	NEW !!! Addressing future evolutions of software infrastructure	23.5
DY1	Improvement of SISL spectral dynamical core (H and NH)	19
DY2	FVM-like solution as an alternative to SISL dynamical core	4
DY3	Development of methods for solving the implicit equation in gridpoint space.	5.5
DA1	Further development of 3D-Var (alg. Settings)	32.5
DA2	Development of flow-dependent algorithms	59.5
DA3	Use of existing observations	130.25
DA4	Use of new observations types	110.5
DA5	Development of assimilation setups suited for nowcasting	53
DA6	Participation in OOPS	21.5
DA7	Observation pre-processing and diagnostic tools	22.5
DA8	Basic data assimilation setup	42.5
PH1	Developments of AROME-France (and ARPEGE) physics	43
PH2	Developments of HARMONIE-AROME physics	24
PH3	Developments of ALARO physics	32.75
PH4	Common 1D MUSC framework for parametrization validation	4
PH5	Model Output Postprocessing Parameters	31.5
PH6	NEW !!! Study the cloud/aerosol/radiation (CAR) interactions	28
PH7	NEW !!! Develop approaches for 3D physics	13.25
PH8	NEW !!! Assess the use of ML for physics parametrizations	11.25
PH9	Consistency and convergence of the CSC physics	5.75
PH10	NEW !!! Litterature survey of existing fully stochastic physics parametrizations	17
SU1	Algorithms for surface assimilation	20.5

SU2	Use of observations in surface assimilation	12
SU3	SURFEX: validation of existing options for NWP	59.5
SU4	SURFEX: development of model components	13.5
SU5	Assess/improve quality of surface characterization	19
SU6	Coupling with sea surface/ocean	13
E1	Arome-France EPS (PEARO)	76
E2.1	Development of convection-permitting ensembles: HarmonEPS - Physics perturbations	22.25
E2.2	Development of convection-permitting ensembles: HarmonEPS - Initial conditions perturbations	4.5
E2.3	Development of convection-permitting ensembles: HarmonEPS - Surface perturbations	11.5
E2.4	Development of convection-permitting ensembles: HarmonEPS - Lateral boundary perturbations	0.5
E2.5	Development of convection-permitting ensembles: HarmonEPS - HarmonEPS system	2
E3	Development, maintenance and operation of convection-permitting ensembles for LACE	19.75
E4	Development, maintenance and operation of LAEF	11
E6	Ensemble calibration	7.5
E7	NEW !!! Develop user-oriented approaches	32.25
MQA1	Development of HARP	11.25
MQA2	Development of new verification methods	18
MQA3	Meteorological quality assessment of new cycles and alleviation of model weaknesses	66
SY1	Code optimization	8
SY2	Maintenance and development of the Harmonie Reference System	9.5
SY3	Revision of the Harmonie scripting system	6
SY4	Towards a more common working environment: explore practical choices, prototyping, scripting	18.25
HR1	(Sub)-km modelling	69.75

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	
COOPE/D, AlJo, FrBo, ErEs, PaPo	COOPE/D, Alain Joly, François Bouyssel, Eric Escalière, Patricia Pottier	Météo-France	2
LTM-Dz	LTM	ONM Algeria	0.25
LTM-Au	LTM	ZAMG Austria	0.25
LTM-Be	LTM	RMI Belgium	0.25
LTM-Bg	LTM	NIMH Bulgaria	0.25
LTM-Hr	LTM	DHMZ Croatia	0.25
LTM-Cz	LTM	CHMI Czech	0.25
LTM-Hu	LTM	OMSZ Hungary	0.25
LTM-Mo	LTM	Maroc Meteo	0.25
LTM-Pl	LTM	IMGW Poland	0.25
LTM-Pt	LTM	IPMA Portugal	0.25
LTM-Ro	LTM	Meteo Romania	0.25
LTM-Sk	LTM	SHMU Slovakia	0.25
LTM-Si	LTM	ARSO Slovenia	0.25
LTM-Tu	LTM	INM Tunisia	0.25
LTM-Tk	LTM	MGM Turkey	0.25

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.2021 first quarter only.

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, COOPE/D, 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, COOPE/D	
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	0.75
MaBe	Martin Bellus	SHMU Slovakia	0.5
OlSp	Oldrich Spaniel	SHMU Slovakia	0.5
JuCe, BeSt	Jure Cedilnik, Benedikt Strajnar	ARSO Slovenia	1
PeSm, AlTr	Petra Smolikova, Alena Trojáková	CHMI Czech	1
BoBo	Bogdan Bochenek	IMGW Poland	0.5
ChWi	Christoph Wittmann	ZAMG Austria	0.5

WP objectives

This WP gives a list of LACE management activities on development of ALADIN-HIRLAM system. 2021 first quarter only.

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	3
DaSa	Daniel Santos	AEMET Spain	2
PaSa	Patrick Samuelsson	SMHI Sweden	1.25
RoRa	Roger Randriamampianina	Met Norway	3
InFr	Inger-Lise Frogner	Met Norway	3
SaTi	Sander Tijm	KNMI Netherlands	3

WP objectives

Management of the HIRLAM activities related to the development of the common ALH system. 2021 first quarter only.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
MGMT 3.1	Coordinate the R&D, validation and maintenance work of the HIRLAM team, in particular of the core group members, in close communication with the ALH MG. 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 3.3	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 for Harmonie-Arome and of the HIRLAM web site.	DaSa, FrLa	https://hirlam.org/trac/wiki, hirlam.org
MGMT 3.6	Organize and coordinate ASM/Workshops, HMG meetings, and working weeks.	All	meetings and workshops

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : MGMT4

WP number	Name of WP
MNGT4	NEW !!! Management ALH
WP main editor	**Piet Termonia, Jeanette Onvlee, Martina Tudor, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PM	Programme Manager	Météo-France	11
CSS	Consortium Scientific Secretary	Météo-France	11
IL	Integration Leader	Météo-France	
AL	Area Leader (8 Areas) => set to 0 for the time being, as we don't know the names and they are probably already committed in the other WPs		
CSC-L	Canonical System Configuration (CSC) Leader: AROME	Météo-France	5.5
CSC-L	Canonical System Configuration (CSC) Leader: ALARO	DHMZ Croatia	5.5
CSC-L	Canonical System Configuration (CSC) Leader: HARMONIE-AROME	KNMI Netherlands	5.5
AlJo, FrBo, COOPE/D, ErEs	Alain Joly, François Bouyssel, COOPE/D, Eric Escalière	Météo-France	5
LTMs	Local Team Manager	ONM Algeria	0.75
LTMs	Local Team Manager	ZAMG Austria	0.75
LTMs	Local Team Manager	RMI Belgium	0.75
LTMs	Local Team Manager	NIMH Bulgaria	0.75
LTMs	Local Team Manager	DHMZ Croatia	0.75
LTMs	Local Team Manager	CHMI Czech	0.75
LTMs	Local Team Manager	OMSZ Hungary	0.75
LTMs	Local Team Manager	Météo-France	0.75
LTMs	Local Team Manager	Maroc Meteo	0.75
LTMs	Local Team Manager	IMGW Poland	0.75
LTMs	Local Team Manager	IPMA Portugal	0.75
LTMs	Local Team Manager	Meteo Romania	0.75
LTMs	Local Team Manager	SHMU Slovakia	0.75
LTMs	Local Team Manager	ARSO Slovenia	0.75
LTMs	Local Team Manager	INM Tunisia	0.75
LTMs	Local Team Manager	MGM Turkey	0.75
LTMs	Local Team Manager	DMI Denmark	0.75
LTMs	Local Team Manager	ESTEA Estonia	0.75
LTMs	Local Team Manager	FMI Finland	0.75
LTMs	Local Team Manager	IMO Iceland	0.75
LTMs	Local Team Manager	MET Eireann	0.75
LTMs	Local Team Manager	LHMS Lithuania	0.75
LTMs	Local Team Manager	KNMI Netherlands	0.75
LTMs	Local Team Manager	MET Norway	0.75
LTMs	Local Team Manager	AEMET Spain	0.75
LTMs	Local Team Manager	SMHI Sweden	0.75

WP objectives

This WP sheet describes the tasks and manpower requested for the Management of the new single ALH consortium. The tasks are summarized from the Terms of Reference defined in the MoU-1. They encompass the link with the governance bodies and daily management aspects, the elaboration and execution of the Rolling Work Plan (RWP) and ensure this RWP enables the implementation of the Consortium 5-year Strategy, the elaboration of documentation, networking and communication.. Awaiting the actual nominations for the various management positions, only abbreviations of positions are referenced.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
MGMT4.1	Execution of GA decisions	PM	
MGMT4.2	Organisation, coordination, minutes of the GA, STAC, PAC, MG meetings	PM, CSS, chairs of GA/STAC/PAC	
MGMT4.3	Elaboration and execution of the RWP, reporting to the GA	PM	RWP submitted to GA
MGMT4.4	Preparation and execution of the annual budget	PM, CSS	budget submitted to GA

MGMT4.5	Management and monitoring of the contributions of Members (incl. manpower), reporting to the GA	PM, CSS	manpower submitted to GA
MGMT4.6	Preparation and publication of the Consortium Newsletter	PM, CSS	2 publications/year
MGMT4.7	Preparation and negotiation of co-operation agreements	PM	
MGMT4.8	Maintenance of the Consortium official web-site where all the relevant information about the project is published	CSS	website
MGMT4.9	Scientific & technical coordination within the 8 topical Areas, implementation of corresponding goals of the Strategy, implementation of RWP tasks, coordination with the CSC Leaders	PM, ALs, IL, CSC-L	
MGMT4.10	Coordination within the CSC teams, link with transversal and topical coordination with PM+AL+IL	CSC-L	
MGMT4.11	Communication and coordination of operational changes of the common system (ARPEGE-AROME) in MF	AlJo, FrBo, COOPE/D	
MGMT4.12	Coordination of the Consortium activities of their respective national project teams	all LTMs	
MGMT4.13	Computing support to Consortium users of MF machines, access to MF machines, offices	ErEs	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible		Time

ALADIN/HIRLAM/LACE WorkPackage description : COM2.1

WP number	Name of WP
COM2.1	Code generation and maintenance: ongoing process, tools already used
WP main editor	**Claude Fischer, Jeanette Onvlee**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
GCO, COOPE/D, AlMa, HaPe, REK, PaSa, FlSu, MFSci	GCO team, COOPE/D, A. Mary, H. Petithomme, R. El Khatib, P. Saez, F. Suzat, Météo-France scientific code experts as requested	Météo-France	80
CNA	Coordinator for Network Activities		
DaDe	Daan Degrauwe	RMI Belgium	0.5
ASCS	Oldrich Spaniel - LACE ASC	SHMU Slovakia	3.5
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)	
PHAS	B. Bochenek (1), P. Sekula (1)	IMGW Poland	3
PHAS	Algerian team	ONM Algeria	
DaSa	Daniel Santos	AEMET Spain	2
UlAn	Ulf Andrae	SMHI Sweden	0.5
ToMo, WidR, JaBa	Toon Moene (2.5), Wim de Rooij (1), Jan Barkmeijer (0.5)	KNMI Netherlands	4
EoWh	Eoin Whelan	MET Eireann	3
ClFi	Claude Fischer (part of my PM reporting)		

WP objectives

This WP lists the major tasks necessary for preparing, building and validating new versions of the shared Aladin-Hirlam NWP System.
The WP 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"). The preparation of new test programs, or making the test environment evolve is referenced in COM2.2. Efforts towards a new and improved common ALH development environment also are described in COM2.2.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
COM 2.1.1	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, COOPE/D, AlMa, HaPe, REK, PaSa, MFSci, PHAS, ASCS	t-code (complete)
COM 2.1.2	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, COOPE/D, AlMa, HaPe, REK, PaSa, MFSci, PHAS, ASCS, SAL, SET, DACA, ClFi	t-code (complete)
COM 2.1.3	Cross-coordination aspects for planning timing and content of T-cycles (exchange of information, tele-meetings, preparatory documents)	COOPE/D, AlMa, CNA, SAL, ClFi	docs
COM 2.1.4	Maintenance, further development and handover (to specific developers) of the code sanity check tool "mitraillette"	HaPe, PaSa, AlMa, COOPE/D, DaDe	non-t-code
COM 2.1.5	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
COM 2.1.6	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)
COM 2.1.7	Maintenance and specific tidying-up of the codes that are being used for computing the PGD/climatological files	FlSu, COOPE/D	t-code & scripts
COM 2.1.8	Pre-release validation and testing, release and maintenance of Harmonie-Arome CMC.	DaSa, UlAn	Non-t-code
COM 2.1.9	Forward phasing of HIRLAM codes to the latest joint cycle. Coordination and enhace HIRLAM scientists collaboration on porting the codes from Harmonie-Arome CMC to the latest cycle available.	DaSa, UlAn, EoWh, WiRo, JaBa	t-code
COM 2.1.10	Preparation of code branches and/or reviewing of other code contributions, in preparation for a T-cycle, from home		t-code

t-code deliverables

Task	Responsible	Cycle	Time

COM 2.1.1	COOPE/D	refer to timing of cycles	CY48 to be declared in August 2020; CY49 tentatively planned in Q2/2021 (tbc)
COM 2.1.2	COOPE/D, AlMa, ClFi	refer to timing of cycles	build CY48T1 (October 2020 - Beg. of 2021)
COM 2.1.7	FlSu, COOPE/D	refer to timing of cycles	the scripts work with CY43T2 in 2019 - the CLIMAKE scripting tool has been distributed among partners in the autumn 2019, and should become the standard scripting tool for computing clim and PGD files on MF machines (from remote)

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM 2.1.3	COOPE/D, AlMa, CNA, SAL, ClFi	documentation, communication	2/year @LTM meeting & @IFS-Arpège coordination meetings
COM 2.1.4	HaPe	scripts, data	
COM 2.1.5	DaSa	h-code	2021
COM 2.1.6	DaSa	documentation, communication	2021
COM 2.1.8	DaSa	h-code	2021
COM 2.1.9	DaSa	documentation, communication	2021

ALADIN/HIRLAM/LACE WorkPackage description : COM2.2

WP number	**Name of WP**
COM2.2	Code generation and maintenance: evolution of the work practices and environment
WP main editor	**Claude Fischer, Jeanette Onvlee**

Table of participants

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth or External project**
AlMa, FlSu, COOPE/D, HaPe, GCO	Alexandre Mary, Florian Suzat, COOPE/D, Harold Petithomme, GCO team	Météo-France	4
RoSt	Roel Stappers	Met Norway	1
DaSa	Daniel Santos	AEMET Spain	2
UlAn	Ulf Andrae	SMHI Sweden	0.5
ClFi	Claude Fischer (part of PM activity reporting)	PM	0

WP objectives

The whole NWP System will consist of a variety of codes, managed as different projects and repositories (e.g. the models core repository, the OOPS repository, the Surfex repository). Developments of the Consortium teams can concern code to be integrated in the models core repository, but also in the others. Among the executable files of the NWP System, some may need to assemble different repositories (e.g. models core + OOPS), when others can be built aside, standalone, and run in different tasks, or in a coupled way (coupling with an ocean model for instance). Methodologies and tools will be explored in order to manage this variety of codes and their evolution, both for the integration of code contributions and the assembling towards System components.
The ecosystem of shared repositories used by the ALH partners (IFS, MF, Harmonie, Surfex, OOPS, …) furthermore requires an ecosystem of technical testing tools. There are several levels of testing which can be ordered along their complexity in terms of components. We need to differentiate testing between component testing (checking a given task produces an expected result) and full System testing (with some level of assessment of non-deterioration of meteorological key parameters). In a more continuous phasing process component testing will gain in importance. New tools will be designed for this.
Other aspects to be considered are a common platform for information exchange, the need for meetings and training.

Descriptions of tasks

Task	**Description**	**Participant abbrev.**	**Type of deliverable**
COM2.2.1	Design a shared multiple repository infrastructure and associated working practices: • Consider how the main code repositories should be re-organized to facilitate sharing. Consider also which additional repositories may need to be shared (e.g. for OOPS, SURFEX, scripts, and/or open source tools) • Explore what could be an efficient and flexible tool to use for the bundling of information from multiple repositories. • Consider what new working practices may be needed for coordinating code developments that could affect several repositories. • Ensure access to the repositories by the main ALH developers sharing the responsibility for the maintenance of the three CSC's.	AlMa, COOPE/D, GCO, ClFi	Script, YML, coordination documents
COM2.2.2	Implement process and tools for systematic technical software validation: The overall task here encompasses the elaboration of a logical structure for the validation process, with common semantics, across the Consortium, and the content of testing for either component testing or full System testing (including the definition of the expected result, the link with code integration and assembling, the timing or the frequency). Aspects to be considered are: • Define the content of the required systematic technical validation tests. Coordinate the development of further component tests where needed. Ensure access to the tests and testing tools by the main ALH developers. The tasks required for the practical implementation of the testing environment and process are described in SY4.2. • Additionally, design and later introduce testing tools for supplementary codes, scripts and tools needed for a fully integrated system (e.g Harmonie Testbed) • Establish a dataflow/infrastructure for the technical testing of code from the main repositories and for integrated system testing, and a concise visualization of the testing outcomes.	AlMa, FlSu, COOPE/D, HaPe, ClFi	Script (in python), input resources (files, namelists, XML etc.)
COM2.2.3	Exploration of an efficient and flexible shared platform for information exchange close to the GIT philosophy. The platform should be easily accessible for any partner. It should enable posting of code contributions, ticketing, assigning tasks, … The cost of transferring existing information to the new platform should be considered. The prototyping of the platforms will be done in SY4.3	AlMa, FlSu, COOPE/D, ClFi	Documentation
COM2.2.4	Define how methods, procedures and working practices may need to be adapted towards a more continuous code integration process for LAM partners and taking into account the link with ECMWF.	AlMa, COOPE/D, ClFi	Documentation
COM2.2.5	Establish regular meetings on Code and System aspects (between 2 and 4 per year) with the aim of creating a community of code maintenance experts. These meetings will be held based on a draft agenda and minutes.	AlMa, COOPE/D, ClFi	

COM2.2.6	Define solutions for training staff on tools, for training staff on how to run components and assembled parts of the System. When needed, training will be organized at different levels to facilitate the transition to a more common and efficient working practice.	AlMa, COOPE/D, ClFi	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : COM3.1

WP number	Name of WP
COM3.1	Maintenance and Partners' implementations of ALH system
WP main editor	**CNA (Piet Termonia, Jeanette Onvlee, Martina Tudor, Claude Fischer)**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MaDe, OlSp	Maria Derkova, Oldrich Spaniel	SHMU Slovakia	2.5
COOPE/D, AlJo, FrBo	COOPE/D, Alain Joly, François Bouyssel	Météo-France	1
all	Belgium team	RMI Belgium	10
all	Croatia team	DHMZ Croatia	14
all	Slovenia team	ARSO Slovenia	13.5
all	Czech Republic team	CHMI Czech	15
all	Austria team	ZAMG Austria	9
all	Hungary team	OMSZ Hungary	11
all	Romania team	Meteo Romania	12
all	Morocco team	Maroc Meteo	
all	Tunisia team	INM Tunisia	11
all	Turkey team	MGM Turkey	11
SysTeam		DMI Denmark	0.5
SysTeam		ESTEA Estonia	0.5
SysTeam		FMI Finland	1.5
SysTeam		IMO Iceland	0.25
SysTeam		MET Eireann	1.5
SysTeam		KNMI Netherlands	1.5
SysTeam		MET Norway	1.5
SysTeam		AEMET Spain	1.5
SysTeam		SMHI Sweden	1.5

WP objectives

The aim of the WP is to support and coordinate the activities leading to implementation of new code version at the Members' NMS; distribute relevant information among Partners, collect 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 the other Partners is needed. Reporting to relevant bodies.

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 code by all members. The work comprises communication with Meteo-France about the content and the schedule of the latest T-release and export version package of the common code; 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.	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 Partners	COOPE/D, AlJo, FrBo	
COM3.1.5	Operational implementations at NMSs	all	
COM3.1.6	Quality assessment of operational suites	all	
COM 3.1.7	Support on porting Harmonie-Arome CSC configuration to different platforms and ensuring platform equivalence	SysTeam	non t-code
COM 3.1.8	Maintenance and troubleshooting support for Harmonie-Arome by system group (e.g. through forum)	SysTeam	non-t-code
COM 3.1.9	Work on backup and trouble-shooting guidelines to ensure smooth operational running	SysTeam	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
COM3.1.2	MaDe (+ HIRLAM PL for system + RC LACE ASC)	latest available export version of a T-cycle	

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

COM 3.1.7	DaSa	h-code	
COM 3.1.8	DaSa	report	
COM 3.1.9	EoWh	report, bug fixes	
COM 3.1.9	UlAn	bug fixes, scripts and optimizations	

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 (0 - if any, this will be part of the PM activity reporting)	Météo-France	
GMAP	any volunteering GMAP staff	Météo-France	4

WP objectives

This WP is specifically devoted to describing the various training and tutorial efforts within Member teams. The training can be either cross-consortium (code training days, on-line tutorials of about codes or scientific material in direct relationship with our common codes, etc.) or local work (eg. spend a few days time explaining code structure, or how to install the codes to a newcomer, etc.). So what counts is the direct link with the common codes and the audience should include NWP Aladin-LACE-Hirlam team staff. To summarize, this WP is about any preparation and provision of training with the aim to increase the scientific and technical knowledge about the common codes.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
COM3.3.1	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 about 3 persons, newcomer ALADIN phasers or GMAP "youngsters".	ClFi	the outcome would be that newcomers become a little IFS/AAAH NWP-aware
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	Postponed from 2020: "data assimilation code training days" are planned in Toulouse in 2021. Due to the COVID- crisis, the specific nature of these training days remains open (physical meeting or somehow remotely ?)	GMAP, others	tutorial material

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : COM3.4

WP number	Name of WP
COM3.4	NEW!!! Attendance and preparation of ASW & EWGLAM
WP main editor	**Jeanette Onvlee, Piet Termonia, Martina Tudor, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PM	Programme Manager (accounted for in MNGT4)	Météo-France	0
CSS	Consortium Scientific Secretary (accounted for in MNGT4)	Météo-France	0
LocOrg	Local Organizer of ASW (or EWGLAM venue if in an ALH country)	ARSO Slovenia	1
CNA	Coordinator for Networking Activities	SHMU Slovakia	0.5
LTMs	Local Team Manager	ONM Algeria	0.75
LTMs	Local Team Manager	ZAMG Austria	0.75
LTMs	Local Team Manager	RMI Belgium	0.75
LTMs	Local Team Manager	NIMH Bulgaria	0.75
LTMs	Local Team Manager	DHMZ Croatia	0.75
LTMs	Local Team Manager	CHMI Czech	0.75
LTMs	Local Team Manager	OMSZ Hungary	0.75
LTMs	Local Team Manager	Météo-France	0.75
LTMs	Local Team Manager	Maroc Meteo	0.75
LTMs	Local Team Manager	IMGW Poland	0.75
LTMs	Local Team Manager	IPMA Portugal	0.75
LTMs	Local Team Manager	Meteo Romania	0.75
LTMs	Local Team Manager	SHMU Slovakia	0.75
LTMs	Local Team Manager	ARSO Slovenia	0.75
LTMs	Local Team Manager	INM Tunisia	0.75
LTMs	Local Team Manager	MGM Turkey	0.75
LTMs	Local Team Manager	DMI Denmark	0.75
LTMs	Local Team Manager	ESTEA Estonia	0.75
LTMs	Local Team Manager	FMI Finland	0.75
LTMs	Local Team Manager	IMO Iceland	0.75
LTMs	Local Team Manager	MET Eireann	0.75
LTMs	Local Team Manager	LHMS Lithuania	0.75
LTMs	Local Team Manager	KNMI Netherlands	0.75
LTMs	Local Team Manager	MET Norway	0.75
LTMs	Local Team Manager	AEMET Spain	0.75
LTMs	Local Team Manager	SMHI Sweden	0.75

WP objectives

There are two yearly meetings where many of the ALH staff meet and which are also used for coordination purposes within ALH: the All Staff Workshop (ASW) and the SRNWP/EWGLAM meeting. The tasks in this work package involve the organisation of the meetings, preparation of presentations/posters, attendance at ASW & EWGLAM, and the preparation of Newsletter contributions related to the ASW. The scientific exchanges during Working Days or Working Weeks belong to the scientific workpackage. Generally the ASW and EWGLAM meetings are held as physical meetings, but in case the meetings will be held in the form of a web conference, attendance of the meetings will also be counted as contributions.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
3.4.1	Preparation of the meeting (venue or online and programme)	CSS, LocOrg, PM	programme, list of participants, any published information or organisational note about the venue
3.4.2	Preparation and presentation of national poster	LTMs	national poster
3.4.3	Attendance	LTMs	
3.4.4	Preparation of Newsletter contribution	LTMs	newsletter contrib.

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : SPTR1

WP number	Name of WP
SPTR1	NEW !!! Addressing future evolutions of software infrastructure
WP main editor	**Piet Termonia, Daan Degrauwe, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
DaDe, PiTe	Daan Degrauwe, Piet Termonia	RMI Belgium	5
ThBu, PhMa, MF	Thomas Burgot, Philippe Marguinaud, other MF/GMAP staff from the dynamics/system (ALGO) and physics (PROC) teams	Météo-France	13
CoCl	Colm Clancy	MET Eireann	4.5
PaMe	Paulo Medeiros	SMHI Sweden	1

WP objectives

In order to address the uncertain future evolution of the software infrastructures we will follow the approach of *separation of concerns* as explained in the ALH Strategy 2021-2025. The challenge is therefore to develop new layers of software that generate an efficient but specific hardware code starting from the high-level abstract code. We will study the domain-specific language (DSL) approach that was adopted by the ECMWF. We will increase our link with ECMWF through the ongoing phasing of specific codes with ECMWF. 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 approach followed in work packages DY2 and DY3, one of the main tasks of this work package is to ensure that the Atlas framework will support our limited-area model configurations. Even though the introduction of Atlas in the IFS is not foreseen for the immediate future, LAM-awareness in Atlas has already been addressed by the ALH community in the past since its early design stage. The next step is to fully integrate the LAM features in the Atlas repository. Lasty, there is a need for flexibility to code components that perform calculations along a single dimension, by means of so-called “single column abstraction” (SCA) of these components. “Horizontal” dimensions, loop ordering and boundaries and of course the exact memory layout of the state variables are abstracted, so the SCA code itself only exposes a compact form of the schemes or codes, with the “vertical” operations only. The ECMWF approach that was developed by Swiss institutions, called CLAW, will be studied and, if suitable, imported from them. To avoid future rewrites, it needs to be adapted to Atlas at the same time as the existing representation of the state variables (GFL, GMV) needs to be made Atlas compatible. The dynamics developments in work packages DY2 and DY3 will stongly rely on the features of Atlas.The ongoing activities of adapting the recent cycles to existing and emerging technologies such as GPUs, and to optimize the code on the existing familiar HPC platforms, are addressed in the SY1 work package.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SPTR1.1	Follow ECMWF's Atlas developments and keep existing LAM features alive.	DaDe	Code on ECMWF git-repository
SPTR1.2	Impact of projection (map factors and compass) on numerical operators like finite-volume derivatives.	DaDe	Code on ECMWF git-repository
SPTR1.3	Atlas (C++) interface to the LAM spectral transforms (“etrans”).	DaDe	Code on ECMWF git-repository
SPTR1.4	Run ESCAPE dwarfs (e.g. sparse solver GCR, SL advection) in LAM configuration.	DaDe, CoCl, PaMe	Code
SPTR1.5	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, CoCl	Code
SPTR2	Adapt the IO server or its ECMWF extension called multIO to Atlas; optimize I/O using Atlas tools	PhMa ?	t-code
SPTR3	Analyse existing approaches to introduce *flexibility in the 1D components*, namely physical parameterizations and surface models. One may rely on introducing OpenACC directives (or the latest OpenMP standard, already a choice to make). Alternatively, one may follow ECMWF and implement single column abstraction, using the Claw-derived software. Both approaches have pros and cons, they need to be analysed and a consortium wide decision must be taken. There seems to be a related decision about which form of the software the development of physics should continue to be performed on, if or when Claw is introduced.	ThBu, PhMa, some MF/ALGO+PROC team members	documentation, Decision on the *1D flexibility approach*
SPTR4	*Training, analysis and documentation*: (i) to get familiarized with Atlas, (ii) on MultIO, (iii) the chosen 1D flexibility approach as decided in SPTR3 and (iv) DSL.	DaDe, Cocl	training material

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : DY1

WP number	Name of WP
DY1	Improvement of SISL spectral dynamical core (H and NH)
WP main editor	**Petra Smolikova & Sander Tijm**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
REK, GhFa	Ryad El Khatib, Ghislain Faure	Météo-France	1
FaVo	Fabrice Voitus	Météo-France	4
PeSm	Petra Smolíková	CHMI Czech	4.5
JoVi	Jozef Vivoda	SHMU Slovakia	4.5
AlCr	Alexandra Craciun	Meteo Romania	2
MaHr, IvDo	Mario Hrastinski, Iva Dominović	DHMZ Croatia	1
BB, PiSe, GaSt	Bohdan Bochenek, Piotr Sekuła, Gabriel Stachura	IMGW Poland	2

WP objectives

The modernization of the current hydrostatic and non-hydrostatic dynamical core of the ALADIN-HIRLAM System. The basic algorithmic choices remain unchanged: semi-implicit or iterative centered implicit time scheme, semi-Lagrangian advection and spectral horizontal representation of prognostic variables with finite difference or finite element representation of vertical operators, and mass based hybrid pressure vertical coordinate. One concern of the development is the stability, in particular related to steep orography that represents conditions for which the nonhydrostatic kernel seems to be less stable compared to its hydrostatic counterpart. Different strategies are currently explored: 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. The exploration of new stability constraints on the design of vertical discretization schemes inspired by modern derivation of the primitive equations. Formulation of Euler equations as the increment of hydrostatic primitive equations allowing to add nonhydrostaticity only gradually.

The maintenance of the current ALADIN-HIRLAM dynamical core: cleaning and pruning of the existing branches, merging different algoritmic choices and extending them to the whole kernel (allowing all meaningfull combinations).

Aspects deserving further study in the coupling and nesting procedure for lateral boudaries: the handling of coupling files, the influence of domain size on the coupling process, 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
DY1.2	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
DY1.3	Reformulation of the nonhydrostatic nonlinear model using new definitions for the vertical motion variable "W" to obtain simple bottom boundary condition with the goal to minimize the residual in the prognostic pressure equation and increase the overall stability of the scheme. 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, JoVi, PeSm	t-code
DY1.4	Refined calculation of vertical Laplacian operator, PGF term and vertical interpolation in the NH model part.	FaVo	t-code
DY1.5	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).	FaVo, JoVi, PeSm	t-code
DY1.6	Extension of the VFE discretization to the new vertical motion variable "W".	FaVo, JoVi, PeSm	t-code
DY1.7	Testing the influence of the definition of vertical coordinate eta on the accuracy of vertical interpolation.	PeSm	non-t-code
DY1.8	Coupling procedure: the influence of increased coupling frequency (1h), reduction of the LBC files size through the frame approach in the LBC files and through the choice of truncation in the LBC files	MaHr, IvDo, BB, PiSe, GaSt	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
DY1.2	AlCr	CY48T1	end 2021
DY1.3	FaVo	CY48T1	end 2021
DY1.4	FaVo	CY48T1	end 2021

DY1.5	JoVi	CY48T1	end 2021
DY1.6	PeSm	CY48T1	end 2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY1.3	FaVo, JoVi, PeSm	Report, scientific paper	end 2021
DY1.5	JoVi	Report	end 2021
DY1.7	PeSm	Report	end 2021
DY 1.8	MaHr, IvDo, BB, PiSe, GaSt	Report	end 2021

ALADIN/HIRLAM/LACE WorkPackage description : DY2

WP number	Name of WP
DY2	FVM-like solution as an alternative to SISL dynamical core
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

Our dynamical core uses a spectral semi-implicit and semi Lagrangian approach. It has proven to be quite efficient, taking advantage of the spectral transforms, allowing a trivial implicit treatment of fast waves to greatly improve efficiency. Because of the possible unmanageable cost of the spectral transforms in the long term, but also because of the potential benefit of more complex schemes, the purpose of that workpackage is to start developing an alternative dynamical core for ALADIN.

Since ECMWF is currently developing a new NH gridpoint dynamical core, named Finite Volume Module (FVM), with a conservative advection scheme and using a new library for geometry and data structure (ATLAS), FVM will be a natural framework for developing this new dynamical core.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SPDY1.1	The possibility to implement a local area version of FVM will be considered. First, the way to develop a local area version of FVM should be studied and carefully looked at, using the possibilities of ATLAS library. Different components of FVM might be of less interest for us (for instance the transport scheme). Research and development orientations should be discussed in a dedicated workshop.		

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
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 : DY3

WP number	Name of WP
DY3	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	4
ThBu	Thomas Burgot (PhD)	Météo-France	1
DaDe	Daan Degrauwe	RMI Belgium	
JoVi	Jozef Vivoda	SHMU Slovakia	0.5

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 : 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	Jana Sanchez (3)	AEMET Spain	3
AlTr, AnBu	Alena Trojakova (2), Antonin Bucanek(3)	CHMI Czech	5
AnSt, SuPa	Antonio Stanesic (1.5), Suzana Panezic (1)	DHMZ Croatia	2.5
XiYa, MaDah	Xiaohua Yang(CARRA), Mats Dahlbom (2)	DMI Denmark	2
WaKh	Wafa Khalfaoui (2)	INM Tunisia	2
RoRa, MaMi,PeDah	Roger Randriamampianina (CARRA, Alertness), Mate Mile (Alertness), Per Dahlgren (CARRA, PRECISE)	MET Norway	
PiBr, PhCh, OlGu	Pierre Brousseau, Philippe Chambon, Oliver Guillet	Météo-France	12
MaLi, MaRi, SuHa, JeBo	Magnus Lindskog (AWS Microsat), Martin Ridal (1.5), Susanna Hagelin (0.5), Jelena Bojarova (iOBS)	SMHI Sweden	2
BeSt	Benedikt Strajnar (1)	ARSO Slovenia	1
MarDer	Maria Derkova (3)	SHMU Slovakia	3

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. The initialisation technique related tasks are now moved to DA6 (DA6.6).
- 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) (See also E2.2.4.); 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, MaRi, RoRa, JaSa, WaKh, SuHa, 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	Scientific note
DA1.3	Large scale information: Compare various mechanisms for taking the large scales into account (Jk, LSMIX, via preconditioning, …). Promising results were observed after implementing the Jk in Harmonie-Arome, but further tuning is still needed. Consider increased lateral boundary condition coupling frequency.	MaDah, XiYa, AnSt	Scientific note
DA1.4.1-2	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, NiGu, MaLi	Scientific note
DA1.5	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, and organise meetings to promote it.	PiBr, PhCh, RoRa, BeSt, AlTr, AnBu, AnSt, PeDah, MarDer, SuPa	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 2021
DA1.2	JeBo	Report on impact of differently computed B matrices	end 2021
DA1.3	MaDah, XiYa	Possible solution for use in the reference system about large scale consideration.	end 2021
DA1.4	RoRa	Specific Harmonie branch ready for OSSE.	end 2021
DA1.5	PiBr, RoRa, BeSt, AlTr	Technical report	end 2021

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, JaSa	Pau Escriba (3) , Carlos Geijo (2), Jana Sanchez (3)	AEMET Spain	8
XiYa	Xiaohua Yang (0.5)	DMI Denmark	0.5
JaBa	Jan Barkmeijer (2)	KNMI Netherlands	2
EoHa, EoWh	Eoghan Harney, Eoin Whelan (1)	MET Eireann	1
RoSt, RoRa, RoAz	Roel Stappers (1) (H2O), Roger Randriamampianina (0.5) (Alertness, H2O), Roohollah Azad (Alertness)	MET Norway	1.5
LoBe, NiGi, CeLo, YaMi, PiBr, EtAr, OlGu, MaDe, VaVo	Loik Berre, Nicole Girardot, Cécile Loo, Yann Michel, Pierre Brousseau, Etienne Arbogast, Oliver Guillet, Mayeul Destouches, Valérie Vogt	Météo-France	40
JeBo, NiGu, MaLi, PaMa	Jelena Bojarova (1), Magnus Lindskog (2), Paulo Madeiros (1)	SMHI Sweden	4
IsMo, VaCo	Isabel Monteiro (2), Vanda Costa (0.5)	IPMA Portugal	2.5

WP objectives

A number of approaches have been investigated in recent years. At the 2020 Strategy meeting, priority topics have been agreed: continuation of maintenance of 3D-VAR, 4D-VAR, hybrid EnVar. For hybrid EnVar, two versions are likely to be explored based on recently published papers. Elements of an LETKF scheme can be considered for the hybrid EnVar approach. At implementation level, a major strategical goal will be to bring the OOPS-based VAR and EnVar to pre-operational stage for a few early members by 2022 or 2023.
Efforts, in the framework of the VAR and EnVar methods, towards the extended use of ensemble information, the efficient correction of hydrometeor fields and improvements in B will be continued.

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, MaRi, RoRa, RoAz, JaSa, WaKh, SuHa, MaMi, OlGu, PaMa, EoHa, EoWh, PaEs, XiYa, JaBa	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; initialisation; 4D-Var and probabilistic verfication frameworks.	JeBo, RoRa	Code and scientific note
DA2.3	EnVar in OOPS: improve scientific options (localization, advection), adapt IAU (to reduce spin-up effects), update 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, PiBr, MaDe, VaVo, RoSt, RoRa, JeBo, MaLi, PaEs, CaGe	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, NiGi, CeLo, OlGu, YaMi, 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	Exploring the available (and not tested) options in LETKF algorithm (ex. cy43) like multiplicative inflation based on observation increments, inflation cycling or balancing methods for initial state.	PaEs	code and scientific notes
DA2.8	Explore the possibilty of extending the control variables in EnVar scheme to support coupled atmospheric and surface data assimilation (see also SU1.9).	RoRa, RoSt	
DA2.9	Explore the implementation of modelization of covariances with Gaussian Integrals for DA of scalar fields (e.g. humidity, clouds, aerosols, etc..) in deterministic and ensemble contexts.	CaGe	code and scientific notes

t-code deliverables

Task	Responsible	Cycle	Time
DA2.1	JaBa, RoSt	CY47 or later	2019-2021
DA2.2	JeBo, PaEs	CY47 or later	2020-2022
DA2.3	LoBe, EtAr, YaMi	prototyping now in CY46T1, porting to CY47T1 on its way. Plan to move to CY48T1 in 2021.	2018-2022
DA2.4	LoBe, YaMi	CY47T1 - CY48T1	end 2020 / 2021
DA2.5	YaMi, PiBr	CY47T1	mostly completed for now. Not all options that have been explored actually are kept for operations for the time being. The topic might be resumed in some future.
DA2.8	RoSt	CY48 or later	2021-2023

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA2.1	MaLi	update of 4D-Var script and namelists for operational application	2019-2021
DA2.2	JeBo	update of Harmonie script and namelists	Harmonie scripts and namelists updated. Testing will continue in 2021
DA2.3	LoBe	scientific papers about progress with OOPS/EnVar	end 2021
DA2.4	LoBe, PiBr, YaMi	1)scientific papers, namelists for the MF suites; 2)mirror suites on MF's new HPC	end 2021
DA2.5	YaMi, PiBr	scientific papers or notes, OLIVE scripting adaptations	for now, status as of end of 2019
DA2.6	JeBo	Scientific paper	end 2021
DA2.7	PaEs, CaGe	Scientific paper	end 2021
DA2.9	CaGe	Code and Scientific paper	end 2021

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, PaEs	Joan Campins(2), Maria Diez(4), Jana Sanchez(4), Pau Escriba (1)	AEMET Spain	11
BeSt, PeSm, ViSv, JuCe	Benedikt Strajnar (1.75), Peter Smerkol (1), Vito Svagelj (1),Jure Cedilnik (2)	ARSO Slovenia	5.75
AnBu, AlTr	Antonin Bucanek (5), Alena Trojakova (3)	CHMI Czech	8
AnSt, SuPa	Antonio Stanesic (1), Suzana Panezić (3.25)	DHMZ Croatia	4.25
MaDah, HeVe	Mats Dahlbom(2), Henrik Vedel(0.5)	DMI Denmark	2.5
DaSch, ErGr,Re,Er	David Schönach (HOPE), Erik Gregow (iOBS), Reima Eresmaa (1.5)	FMI Finland	1.5
SiTh	Sigurdur Thorsteinsson (3)	IMO Iceland	3
HaBe, WaKh	Haythem Belgrissi (1), Wafa Khalfaoui (1)	INM Tunisia	2
IsMo, MaMo	Isabel Monteiro(2), Maria Monteiro (1.5)	IPMA Portugal	3.5
SdH, WiVe, JaBa	Siebren de Haan(1), Wim Verkleij(6), Jan Barkmeijer(1)	KNMI Netherlands	8
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui	Maroc Meteo	2
RoDa, EoHa	Ronan Darcy (3), Eoghan Harney (1.5)	MET Eireann	4.5
MaMi, RoRa, PeDah	Máté Mile (Alertness), Roger Randriamampianina (0.5), Per Dahgren (CARRA, PRECISE)	MET Norway	0.5
FrGu, NaFo, ViGu, PaMo, ViPo, ErWa, MaMa, JFMa, ChPa, MaBo, OlDu	Frank Guillaume, Nadia Fourrié, Patrick Moll, Vivien Pourret, Maud Martet, J.-F. Mahfouf, C. Payan, 1 or 2 newcomers in the GMAP/OBS team (provisional accounting of 2 times 0.5 FTE), Mary Borderie, Olivier Dupont	Météo-France	25
DuAk, YeCe	Duygu Aktaş (1), Yelis Cengiz (3)	MGM Turkey	4
ViHo, ZsKo, KrSz, GaTo	Viktoria Homonnai (0.5), Zsofia Kocsis (0.5), Kristof Szanyi (5), Gabriella Toth (2)	OMSZ Hungary	8
GhCh, MOAM	Ghiles Chemrouk (2), Mohand Ouali Ait Meziane (2)	ONM Algeria	4
MaDe,MiNe, MaIm, KaCa, JoVi	Maria Derkova (1), Michal Nestiak (4), Martin Imrisek (4), Katarina Catlosova (8), Jozef Vivoda (1)	SHMU Slovakia	18
MaLi, MaRi, GuHa	Magnus Lindskog(1), Martin Ridal(2.25), Günther Haase(0.5)	SMHI Sweden	3.75
FlMe, FlWe	Florian Meier (3), Florain Weidle (3)	ZAMG Austria	6
AlDu	Alina Dumitru (1)	Meteo Romania	1
MSG, GaSt	Malgorzata Szczech-Gajewska (1), Gabriel Stachura (2)	IMGW Poland	3
LeDC, AlDe, IdDe	Alex Deckmyn (1)	RMI Belgium	1

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 dealiassing 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. Perform monitoring and assimilation of various European radars. Test radar based initialisation of hydrometeors.	AnBu, AnSt, FlMe, MiNe, MaDah, MaRi, WiVe, GuHa, AlTr, FrGu, MaMa, JFMa, ZaSa, JaBa, JaSa, BeSt, PeSm, ViSv, KrSz, DuAk, EoHa, SuPa, MaMo, JoVi, KaCa, MSG, GaSt, DuAk, FiMe	T-codes and scientific note
DA3.2	Aircraft-derived data (ADD): assist implement Mode-S wind and temperature (EHS and MRAR) pre-processing; refine quality control, thinning/super-obbing; evaluate VarBC for ADD; impact assessment.	BeSt, JK, SdH, RoRa, FlMe, FrGu, ViPo, PaMo, MaRi, MaLi, MaDe, KaCa, FiMe, MaDi,LeDC, AlDe, IdDe, GaTo, JaSa, KaCa	T-codes and scientific note

DA3.3	Ground-based GNSS ZTD: further elaborate the assimilation of ZTD data, including onboard train measurement, 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, SiTh, MaLi, HeVe, PaMo, MaIm, FaHd, BeSt, MiIm, FIMe,LeDC, AlDe, IdDe, RoDa, SuPa, GhCh, FiMe, FiWe	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~~; Port the supermodding approach into the common code; 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 (use of high resolution product).	MaMi, IsMo, BeSt, ChPa	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, TL, ZsKo, ViHo, RoRa, PeDah, YeCe	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, SiTh, MaDi, JoCa, WaKh, MaLi, RoRa, ReEr, MOAM	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.	HaBe, MaDe	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, RoRa, JaSa, RoSt, ErGr, MaRi, MiNe	T-codes and scientific note
DA3.10	Assimilation of sodar data	JuCe	T-codes and scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA3.1	MaDa	CY48T1 or later	end 2021
DA3.2	EoWh, RoRa, PM	CY48T1 or later	end 2021
DA3.3	MaLi, HaBe, PaMo	CY48T1 or later	end 2021
DA3.4	GJM	CY48T1 or later	end 2021
DA3.5	EoWh, RoRa	CY48T1 or later	end 2021
DA3.6.1	MaDi	CY48T1 or later	end 2021
DA3.6.2	SiTh, RoRa	CY48T1 or later	end 2021
DA3.6.3	MaDa	CY48T1 or later	end 2021
DA3.8	EoWh	CY48T1 or later	end 2021
DA3.10	JuCe	CY48T1 or later	end 2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA3.1	MaMo	Common pre-processing and Bator for (OPERA) radar data.	end 2021
DA3.4	IsMo	Report about the implementation of the different observations	end 2021
DA3.61-3	JaSa	Report about the impact assessment	
DA3.7			
DA3.9	Pa Es	Report about system (scripts and namelist) update and impact assessment	end 2021

ALADIN/HIRLAM/LACE WorkPackage description : DA4

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
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	1
MaDi, CaGe	Maria Diez (2), Carlos Geijo(1)	AEMET Spain	3
IsMo	Isabel Monteiro (0.5)	IPMA Portugal	0.5
RoDa, EoWh	Ronan Darcy, Eoin Whelan (1)	MET Eireann	1
MaLi, SuHu, MaRi, PaMa	Magnus Lindskog (Mode-S project, AWS miscosat), Susanna Hagelin (Aeolus, AWS), Martin Ridal (0.5) (iOBS), Paulo Madeiros (iOBS)	SMHI Sweden	0.5
RoRa, RoAz, RoSt	Roger Randriamampianina(Alertness), Roohollah Azad (Alertness), Roel Stappers (1) (iOBS)	MET Norway	1
ReEr	Reima Eresmaa (1.5)	FMI Finland	1.5
PaMo, ErWa, FrGu, NaFo, PhCh, FaDu, ViPo, ChPa, JFM, GuTh, MaBa, MaSa, OlCo	Patrick Moll, Maud Martet, Frank Guillaume, Nadia Fourrié, Philippe Chambon, Vivien Pourret, Christophe Payan, Jean-François Mahfouf, Guillaume Thomas, Marylis Barreyat, Matic Savli, Olivier Coopmann	Météo-France	85
OlCa	Olivier Caumont	Météo-France	
MOAM	Mohand Ouali Ait Meziane (2)	ONM Algeria	2
FlMe, PhSc	Florian Meier (0.5), Phillip Scheffknecht (4)	ZAMG Austria	4.5
BeSt, PeSm	Benedikt Strajnar (1.5), Peter Smerkol (2)	ARSO Slovenia	3.5
MaIm	Martin Imrisek (2), Michal Nestiak (2)	SHMU Slovakia	4

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. Explore the application of machine learning technique in quality control of high temporal and spatial resolution observations.

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, PhCh, MaBa, JFM, MOAM	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, MaIm	Codes and scientific note
DA4.3	GNSS ZTD horizontal gradients: Perform impact studies with data provided by IGN.	PaMo, FaHd, FrGu	Codes and scientific note
DA4.4	High-resolution surface observations (surface pressure, T2m, q2m): further explore the potential of volunteered observations from crowdsourced, private weather sations, cars, and smartphones. Implement the machnie learning technique to quality control these observations in the common T-code.	KaHi, CdB, RoSt, MaRi, OlCa, RoDa, PaMa, FiMe	Codes and scientific note
DA4.5.1-6	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), 5) EPS SG-MWS, 6) AWS-MW.	RoAz, FruG, ViPo, ChPa, IsMo, MaLi, SuHa, MaSa, ViPo, ChPa, EoWh, ReEr	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.	MaDi, PaMo	Code and scientific note
DA4.7	Set-up a new framework for OSSEs with full AROME observing system (including radar data) for the preparation of IRS/MTG in AROME 3D-Var	NaFo, OlCo, PhCh	Code and scientific note
DA4.8	Assimilate wind data from recreational hot-air balloon flights in HARMONIE-AROME	CdB	Code and Scientific note
DA4.9	Start to explore the different products (cloud-related products, also AMVs) from SAF/NWC in DA processes (short-range and nowcasting applications). See also PH6 and MQA3.	CaGe	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, PeSm, PhSc	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	CY48T1 or later	2020-2021
DA4.2	SdH, MaIm	CY48T1 or later	2020-2021
DA4.4	KaHi	CY48T1 or later	End of 2021
DA4.5.1-4	1-RoAz, FrGu	CY48T1 or later	End of 2021
DA4.6	MaDi, PaMo	CY48T1 or later	End of 2021
DA4.7	NaFo	CY48T1 or later	End of 2021
DA4.8	CbB	CY48T1 or later	End of 2021
DA4.9	CaGe	CY48T1 or later	End of 2021
DA4.10		CY48T1 or later	End of 2021

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 2021
DA4.7		Technical report	End of 2021
DA4.8	CdB	Technical report	End of 2021
DA4.11	CdBOlCa, MaMa	Technical report	End of 2021

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

3	Participant	Institute	PersonMonth or External project
CaGe, MaDi	Carlo Geijo (5), Maria Diez(1)	AEMET Spain	6
BeSt	Benedikt Strajnar (1.5)	ARSO Slovenia	1.5
AlTr, AnBu	Alena Trojakova (0.5), Antonin Bucanek(0.5)	CHMI Czech	1
XiYa, ClPe, KaHi	Xiaohua Yang (1.5), Claus Pedersen(2), Kasper Hintz(1.5)	DMI Denmark	5
ErGr	Erik Gregow (3)	FMI Finland	3
SdH, JaBa	Siebren de Haan (1), Jan Barkmeijer (1)	KNMI Netherlands	2
FaHd, ZaSa	Fatima Hdidou (1), Zahra Sahlaoui (1)	Maroc Meteo	2
ViHo, GaTo	Viktoria Homonnai (3), Gabriella Toth (3)	OMSZ Hungary	6
PiBr, NiMe, ThMo	Pierre Brousseau (0.5), Nicolas Merlet (9.5), Thibaut Montmerle (2.25)	Météo-France	12.25
MiNe, MaDia	Michal Nestiak(3), Martin Dian (1)	SHMU Slovakia	4
MaLi, ToLa, JeBo	Magnus Lindskog(MetCoOp) (1.5), Tomas Landelius (SEA), Jelena Bojarova (0.75)	SMHI Sweden	2.25
FlMe	Florian Meier (2.5)	ZAMG Austria	2.5
EoHa	Eoghan Harney (1.5)	MET Eireann	1.5
LeDC	Lesley De Cruz	RMI Belgium	
AhMe, IvAn,SuTo	Ahto Mets(0.5), Ivar Ansper(1), Sulev Tokke(2.5)	ESTEA Estonia	4

WP objectives

Nowcasting and very short range forecasting (~1-6h) 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 presently being experimented with, with plan of development using 4DVAR or 4DEnVar on overlapped assimilation windows. 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. Especially, high density crowd source data such as smartphone pressure measurement and measurement from private weather network provides potentially useful information for capturing rapidly developing system in small scale. 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, algorithm development in 4DVAR and 4DEnVAR will also be extended to nowcasting applications, in which particular focus will be given on approaches for an effective minimisation and quick delivery. HIRLAM will also explore cloud initialization technique (using satellite imagery to initialize model humidity fields) to utilise 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 will also be 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,AO, crowd source ...): monitor observations usage; evaluate quality, promote data exchange from local observation networks.	SdH, ErGr, FlMe, BeSt, MiNe, MaMo, ZaSa, MaDia, ViHo,GaTo, KaHi,MaDi	Codes and scientific note
DA5.2	Assimilation cycling strategy: evaluate aspects of assimilation setup with various assimilation schemes (3D, 4D, deterministic and ensemble) on updating frequency, rapid refresh (RR) vs RUC. Test of rapid refresh with use of moving assimilation window and assimilation cycling with overlapping windows. Test the optimal use of all high resolution (horizontally and temporally) observations in case of 4D approach.	RoAz, XiYa, KaHi, ErGr, ClPe, FlMe, MaLi, JaBa, NiGu, CaGe, LeDC, EoHa, JeBo, BeSt, IvAn, SuTo, GaTo, FaHd,ZaSa,NiMe,ThMo, PiBr	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. Consider HDF5 format usage in Field Alignment context.	CaGe	Codes and scientific note
DA5.4	Towards cloud initialisation: initialize humidity fields from CPP products and evaluate their impact on the cloud initialization; study pre-conditioning of the first guess using radar data. Study weather regime dependent balances between hydrometeor model variables and control state variables, possibly using ensemble techniques.	ErGr, MaLi, ToLa, MiNe, ClPe	Codes and scientific note
DA5.5	Optimize setup for nowcasting range: optimize design and implementation of a data assimilation system both in terms of algorithm (3DVAR, 4DVAR on overlapped windows) and high density observation data suitable for the very short range (0-6h). Test of combination of upper air 4DVAR or 3DVAR for coarse resolution domain with internally nested high resolution downscaling using radar data nudging.	SuTo, AhMe, AlTr, AnBu,PiBr	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
DA5.7	Test of EnVar under OOPS for nowcasting.	NiMe, ThMo, PiBr	Codes and scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA5.4	ErGr	CY48T1	end 2020

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA5.1	SdH	script and code in CY43h2 or CY46h1	end of 2021
DA5.2	PiBr	script and code	end of 2021
DA5.3	CaGe, RoRa	script and code in CY43h2 or CY46h1	end of 2021
DA5.5	RoAz, XiYa	script and code in CY43h2 or CY46h1	end of 2021
DA5.6	JeBo	script and code	end of 2021

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	Roel Stappers, Roger Randriamampianina	MET Norway	3
DaSM, PaEs, CaGe	Daniel Santos-Munoz, Pau Escriba, Carlos Geijo	AEMET Spain	
EtAr, AlMa, REK, FlSu, FaVo, HaPe, PiBr, VaVo	Etienne Arbogast, Alexandre Mary, Ryad El Khatib, Florian Suzat, Fabrice Voitus, Harold Petithomme, Pierre Brousseau, Valérie Vogt	Météo-France	18
DaDe	Daan Degrauwe	RMI Belgium	0.5
JeBo, MaLi	Jelena Bojarova (0.5), Magnus Lindskog (0.5)	SMHI Sweden	
EoWh	Eoin Whelan	MET Eireann	
ClFi	Claude Fischer (part of my PM reporting)		

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 perhaps not in the very first e-suite there (2022 or even 2023, tbc). For MF, this would actually mean to prepare for a switch of all or part of their assimilation systems at roughly the same time as EC.

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 (short term: proto at MF; mid-term: managed via ECMWF repo) and in support to scientists (for getting hand-on the OOPS system)	EtAr, RoSt	t-codes, OOPS interface codes
DA6.3	Consolidate the prototypes of assimilation as unit tests, including tests of OOPS objects. Implement in DAVAÏ framework. Plan visit by Roel to MF and/or assess the possibility for an enhanced remote collaboration by Roel with MF team.	EtAr, AlMa, RoSt, ClFi	non t-codes
DA6.4	Develop prototype of full assimilation cycle using OOPS binaries, in the OLIVE/VORTEX (MF) and in the Harmonie frameworks. This work will require collaboration first on keeping consistent solutions with unit testing (DA6.3) and exchange of results.	EtAr, PiBr, VaVo, RoSt, MaLi, RoRa, PaEs, CaGe, EoWh	non t-codes
DA6.5	Full-POS for OOPS & use of the new configuration "903"	REK	t-codes
DA6.6	Specific ARPEGE/LAM issues for re-factoring (DDH, LBC)	AlMa, FaVo, HaPe	t-codes
DA6.7	Digital filter initialization; Incremental Analysis Update (IAU) in OOPS	DaDe, PiBr	t-codes
DA6.8	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
DA6.9	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, RoRa	minutes of meetings

t-code deliverables

Task	Responsible	Cycle	Time
DA6.1	ECMWF/MF coordination (coordinators)	from CY46T1 to CY48T1	end 2021
DA6.2	EtAr & RoSt	?	?
DA6.5	REK	CY47T1, CY48	completed and integrated in code
DA6.6	AlMa	CY47T1, CY48	completed and integrated in code
DA6.7	?	?	?
DA6.8	RoSt	after CY48T1	2021 or later

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA6.3	EtAr+AlMa for MF prototypes	updated prototype codes (outside IFS cycles)	?
DA6.9	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), Maria Diez (1)	AEMET Spain	2
AlTr	Alena Trojakova (4)	CHMI Czech	4
BjAm, MaDah	Bjarne Amstrup (2), Mats Dahlbom(2)	DMI Denmark	4
SiTh	Sigurdur Thorsteinsson (1)	IMO Iceland	1
ViHo	Viktoria Homonnai (1)	OMSZ Hungary	1
IsMo, VaCo	Isabel Monteiro (0.5), Vanda Costa (0.5)	IPMA Portugal	1
EoWh	Eoin Whelan (1)	MET Eireann	1
HeBe, FrGu, DoPu, DoRa	Hervé Benichou, Frank Guillaume, Dominique Puech, Dominique Raspaud (6)	Météo-France	6
PaMa	Paulo Medeiros (0.5)	SMHI Sweden	0.5
HaBe	Haythem Belghrissi (1)	INM Tunisia	1
MuSe	Mustafa Sert (1)	MGM Turkey	1

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.	MaDi(0.5), EoWh (0.5), MaDah (1), BjAm (1)	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), MaDi(0.5), MaDah (1), HeBe, DoPu, DoRa, PaMa (0.5), SiTh (1)	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 such as All-Sky radiances and MTG-IRS sample data provided by EUMETSAT. Implementation of ADM Aeolus was a good cooperation Meteo France and MET Norway in 2018-2019. Investigate possibility to produce ODB2 formatted feedback output from the Screening and Minimization tasks.	EoWh (0.5), BjAm(1), FrGu	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.	BjAm(1), IsMo(0.5), VaCo(0.5), AlTr(1), MuSe(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(3), ViHo(1), HaBe (1)	non-T-codes, report

T-code deliverables

Task	Responsible	Type of deliverable	Time
DA7.1	EW	CY48T1	end 2021

Non-t-code deliverables

Task	Responsible	Cycle	Time
DA7.1	EoWh	CY48	end 2021
DA7.2	DoRa	Technical report	end 2021
DA7.2.1		script and code	end 2021
DA7.2.2	RoRa	script and play-file	end 2021
DA7.2.3	PaMa	script and code (CI)	end 2021
DA7.2.4	RoRa	CI	end 2021

DA7.3	EoWh	CY48	end 2021
DA7.4	IsMo, EoWh	Technical note	end 2021
DA7.5	AlTr	Technical note	end 2021

ALADIN/HIRLAM/LACE WorkPackage description : DA8

WP number	Name of WP
DA8	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, GaSt	Malgorzata Szczech-Gajewska (3), Gabriel Stachura (1)	IMGW Poland	4
HaBe, WaKh	Haythem Belgrissi (2), Wafa Khalfaoui (1)	INM Tunisia	3
MaMo	Maria Monteiro (6)	IPMA Portugal	6
ZaSa, FaHd	Zahra Sahlaoui (4), Fatima Hdidou (1)	Maroc Meteo	5
AlGu, MeSe, YeCe	Alper Güser (1), Meral Sezer (1), Yelis Cengiz (4)	MGM Turkey	6
AnBo,BoTs,RiVa, MiTs	Andrey Bogatchev (1), Boryana Tsenova (1), Rilka Valcheva (1), Milen Tsankov (1)	NIMH Bulgaria	4
MOAM, GhCh	Mohand Ouali Ait Meziane (3), Ghiles Chemrouk (2)	ONM Algeria	5
AlDe,IdDe,LedC	Alex Deckmyn (3), Idir Dehmous (3), Lesley de Cruz (0.5)	RMI Belgium	6.5
AlDu	Alina Dumitru (3)	Meteo Romania	3

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
DA8.1	**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, MaMo(0.25)	technical reports
DA8.2	**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, MaMo (0.25)	code and technical reports
DA8.3	**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. Discussion/validation of implemented data processing systems.	All, MaMo (0.25)	code and technical reports
DA8.4	**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, MaMo (0.25), MeSe (1), ApGu (1)	reports
DA8.5	**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. For a combined surface+upper-air variational algorithm, a first B-matrix needs to be computed (locally or remotely). Besides, sharing a common verification tool suitable for local observations usage is a need.	Be, Pt, Tn, Tk, MaMo (4), YeCe (2)	scientific reports

DA8.6	**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 (including B-matrix computation) 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, MaMo (1), YeCe (2)	Code and technical or scientific reports

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA8.1		all countries have access to SYNOP (local in some cases), TEMP, AMDAR and BUOY data	End 2021
DA8.2		Updates on code and technical note	End 2021
DA8.3		joint local porting/validation in CY43T2 - SYNOP, TEMP, AMDAR	End 2020
DA8.4		joint local implementation of OBSMON	End 2021
DA8.5		basic scripts KIT (combined oi_main + 3D-var) for testing and validation	End 2022
DA8.6	AlDe, MaMo	discussion on combined oi_main+3D-Var basic set of scripts	End 2022

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	
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	11
ChLa, SeRi, BeVi, QuLi	Christine Lac, Sébastien Riette, Benoit Vié, Quentin Libois : CNRM/GMME	Météo-France	23
HaDh, RaBR	Hajer Dhouioui, Rahma Ben Romdhane	INM Tunisia	3
MoMo, AbAm, AbBa	Mohamed Mokhtari (1), Abdenour Ambar (2), Abdelhak Bahlouli (1.5)	ONM Algeria	4.5
ChWi	Christoph Wittmann	ZAMG Austria	0.5
BoTs	Boryana Tsenova	NIMH Bulgaria	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, add fog deposition term in ICE3, 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. A study has revealed a non-conservativity of rain by the dynamics in AROME. Adjustments of lagrangian interpolators have improved precipitation forecast for some cases on the south-east of France	YaSe, ErBa, RaHo, SeRi, HaDh(1), RaBR (0.5), KEL, ChWi, BoTs	doc, t-code
PH1.2	LIMA microphysics scheme development	BeVi, ChLa, HaDh(1), RaBR(0.5)	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. Collaboration with ECMWF to construct a new Estimated Inversion Strength (EIS) in IFS.	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, YaSe	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
PH1.1	YaSe (fog deposition, cleaning of microphys interface)	CY48T1	2021
PH1.3	PaMa	CY49T1 ?	2022 ?
PH1.6	YaSe (writing of DDH surface fields)	CY48T1	2021
PH1.7	YvBo	CY48T1 or later, and CY46T1_op for an e-suite in 2020/2021	2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH1.1	YaSe	presentation on SL adjustment	2020
PH1.3	PaMa	short note for WGNE yearly bulletin	2020

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, DMP	Javier Calvo (1), Daniel Martin Perez (2)	AEMET Spain	3
KPN	Kristian Pagh Nielsen	DMI Denmark	1
LaRo	Laura Rontu (1)	FMI Finland	1
WdR, SaTi, SeCO, NaTh	Wim de Rooij (3.5), Sander Tijm, Sebastián Contreras Osorio (4.5), Nathalie Theeuwes (1)	KNMI Netherlands	9.5
EmGl, EwMA	Emily Gleeson (1), Ewa McAufield (3)	MET Eireann	4
BJE, TeVa, MaKa	Bjorg Jenny Engdahl (3), Marvin Kähnert (ext, 9)	MET Norway	3
KII, MeSh	Karl-Ivar Ivarsson (1), Meto Shapkalijevski (1.5)	SMHI Sweden	2.5
DaBe	Danijel Belusic (ext)	SMHI Sweden	

WP objectives

Verify and where possible improve the general representation of clouds and microphysics (tasks PH2.1 - PH2.2). Weaknesses like the too weakly precipitating cold outbreak convection are studied and where possible improved. 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 is done for all CSCs to improve the realism of the radiation schemes and the interaction between radiation and clouds and/or aerosol (tasks PH2.3 - PH2.5, mostly moved to PH6). 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 PH2.6 – PH2.7). Especially the generally too low nighttime temperatures and the failure to represent observed very low temperature minima in very cold conditions will be targeted. Improvements for fog that were found in 2020 will be consolidated in a further developing environment with LIMA as microphysics scheme and NRT aerosols.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH2.1	Convection: One of the biggest remaining problems in HARMONIE-AROME is the inability of the model to represent open cell convection. In this problem microphysics (no formation of cloud ice/snow/graupel for showers warmer than -15°C), shallow convection and possibly also the evaporation over the sea may play a role. In addition the impact of te increase of horizontal and vertical resolution on the physics, especially on clouds and turbulence, has to be studied.	JaCa, SaTi, KII, WdR, MeSh, MaKa, BJE	t-code, configuration, report
PH2.2	Microphysics: Explore the behaviour of LIMA. Explore the behaviour of preciptiation at the lateral boundaries (nesting problems). Possible extension and testing of Thompson microphysics scheme in the LIMA framework. The work on fog has shown that the microphysics is very sensitive to the CCN's. The allowed supersaturation has a very strong impact on which and how many of the NRT-aerosols are activated, and thereby has a strong impact on fog and other cloud formation. This therefore has to be studied and modelled in the right way. Cloud water path from satellite observation will be used to verify the best settings in the microphysics.	KII, BJE, DMP, DaBe, SeCO	t-code, namelist
PH2.3	Import effective size of cloud ice, cloud liquid, graupel, snow and rain particles from microphysics to the radiation schemes. Externalise effective radius calculations from inside IFSRADIA, ACRANEB2 and HLRADIA; develop, recode, test within MUSC cy46. Explore the possibility to derive the cloud cover from the subgrid fraction and the optical depth of each water species. Connected to consortium-wide task PH6.	KII, EmGl	t-code, namelist
PH2.4	Radiation: Introduce hlradia to h-code within cy46, test in 3D experiments. Compare and test hlradia-acraneb-ifsradia-(later ecrad), considering them as multi-physics options in HarmonEPS. Connected to consortium-wide task PH6. The cloud-aerosol-radiation interaction is handled in PH6.	LaRo, EmGl, KPN	t-code, namelist
PH2.5	SBL/Fog studies: Study the influence of vertical resolution on decoupling in SBL and fog formation, study cloud microphysics (LIMA) and NRT aerosol and the activation of aerosols.	WdR, EmGl, EwMA, SaTi, SeCO, DMP	t-code, namelist
PH2.6	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	KPN, SaTi	t-code, namelist

PH2.7	A wind-farm parametrization (momentum drag) has been developed by KNMI. This parametrization should be implemented in the ALADIN-HIRLAM NWP system.	NaTh	t-code, namelist, database

t-code deliverables

Task	Responsible	Cycle	Time
PH2.1	WdR, SaTi		
PH2.2	KII		
PH2.3	KPN		
PH2.4	LaRo		
PH2.5	WdR, SaTi	43h2.2	
PH2.6	KPN		
PH2.7	NaTh	CY46	Q4 2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH2.1	WdR	Namelist	
PH2.2	KII	Namelist	
PH2.3	KII	Namelist	
PH2.4	LaRo	Namelist	
PH2.5	SaTi	Namelist	
PH2.6	KPN	Namelist	
PH2.7		Namelist, wind farm database	

ALADIN/HIRLAM/LACE WorkPackage description : PH3

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PeSm, NePr	Peter Smerkol, Neva Pristov	ARSO Slovenia	2
RaBr, JaMa, FiSv	Radmila Brožkova, Jan Mašek, Filip Švabik	CHMI Czech	17.25
MaHr, MaTu	Mario Hrastinski, Martina Tudor	DHMZ Croatia	4
BoBo, PiSe	Bogdan Bochenek	IMGW Poland	3
MiVa	Michiel Vanginderachter	RMI Belgium	2
MaDi, MaDe	Martin Dian, Maria Derkova	SHMU Slovakia	4.5

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, single precision	JaMa	doc, t-code
PH3.2.1	TOUCANS scheme – code re-organization, cleaning, debugging	RaBr, JaMa, PeSm	doc, t-code
PH3.2.2	TOUCANS scheme – mixing length computation	MaHr, RaBr	doc, t-code
PH3.3	Cloud scheme, shallow convection cloudiness	JaMa, RaBr	doc, t-code
PH3.4	Non-saturated downdraught		doc, t-code
PH3.5	Complementary Subgrid Drafts (CSD)		doc, t-code
PH3.6	Microphysics – prognostic graupl	BoBo, RaBr	doc, t-code
PH3.7	Surface aspects - coupling ALARO-1 and SURFEX	MaDi, JaMa, RaBr, FiSv, NePr, MaTu	doc, t-code
PH3.8	ALARO-1 validation and maintenance	JaMa, RaBr, MaDe, MaTu, MiVa	t-code
PH3.9	Improvement of DDH tool for ALARO	MaHr	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 (0.5)	KNMI Netherlands	0.5
EoWh, EmGl	Emily Gleeson (0.5), Eoin Whelan	MET Eireann	0.5
ErBa, YvBo, RaHo, JMP	Eric Bazile, Yves Bouteloup, Rachel Honnert, Jean-Marcel Piriou	Météo-France	2
DaDe	Daan Degrauwe	RMI Belgium	0.5
MaTu	Martina Tudor	DHMZ Croatia	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, MaTu	
PH4.2	Create and add (idealized) test cases	WdR, JMP, EmGl	
PH4.3	MUSC training and working days	MaTu	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH4.2	WdR, ErBa, BJE, EmGl	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 (1), Jure Cedilnik (1.5)	ARSO Slovenia	2.5
BeSa	Bent Hansen Sass	DMI Denmark	0.25
SaTi	Sander Tijm	KNMI Netherlands	0.5
FrBo, OlJa, InEt, RaHo, JMP	Francois Bouyssel, Olivier Jaron, Ingrid Etchevers, Rachel Honnert, Jean-Marcel Piriou	Météo-France	9
AnSi	Andre Simon	SHMU Slovakia	3
MaDe	Maria Derkova	SHMU Slovakia	0.5
ChWi	Christoph Wittman (0.5 PM in PH5.2, 1 PM in PH5.3)	ZAMG Austria	1.5
FlWe	Florian Weidle (1 PM PH5.3)	ZAMG Austria	1
InMu	Ines Muic	DHMZ Croatia	1.75
KrHo	Kristian Horvath	DHMZ Croatia	1
MaTu	Martina Tudor (PH5.3)	DHMZ Croatia	0.5
GeMo	Gema Morales	AEMET Spain	2
MaKo	Marcin Kolonko	IMGW Poland	2
KaEK, NaMa	Kamal El Karouni, Najla Marass	Maroc Meteo	2
RiVa	Rilka Valcheva	NIMH Bulgaria	1
KoMl	Konstantin Mladenov	NIMH Bulgaria	1
AhMe	Ahto Mets	ESTEA Estonia	2

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 to implement, tune and validate these parameters into the common t-code.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH5.1	preparation of a workplan for implementation of selected postprocessing parameters into the code	all	work plan
PH5.2	Improvements, tuning and validation of existing model output postprocessing/diagnostic fields		t-code, reports
PH5.3	Development and implementation of new model output postprocessing/diagnostic fields		t-code, reports

t-code deliverables

Task	Responsible	Cycle	Time
PH5.2	??	CY48-CY49	2021
PH5.3	??	CY48-CY49	2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH5.1	??	work plan	2021
PH5.2	??	reports, notes	2021
PH5.2	??	reports, notes	2021

ALADIN/HIRLAM/LACE WorkPackage description : PH6

WP number	Name of WP
PH6	NEW !!! Study the cloud/aerosol/radiation (CAR) interactions
WP main editor	**Laura Rontu & Ján Mašek**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
DMP	Daniel Martin Perez	AEMET Spain	4
EmGl	Emily Gleeson	MET Eireann	3
JaMa	Ján Mašek	CHMI Czech	1.5
KII	Karl-Ivar Ivarsson	SMHI Sweden	0.5
KPN	Kristian Pagh Nielsen	DMI Denmark	0
LaRo	Laura Rontu	FMI Finland	2.5
PiSe	Piotr Sekula	IMGW Poland	2
MoMo, AbAm	Mohamed Mokhtari, Abdenour Ambar	ONM Algeria	4
UlAn	Ulf Andrae	SMHI Sweden	0.5
YaSe, ViGu	Yann Seity, Vincent Guidard & his team	Météo-France	5
AnSl	Ana Šljivić	DHMZ Croatia	2
HaDh, RBR	Hajer Dhouioui, Rahma Ben Romdhane	INM Tunisia	3

WP objectives

ONE LINE SUMMARY: Build a unified framework to treat cloud/aerosol/radiation (CAR) interactions from external aerosol concentration sources and optical properties to the radiation and cloud microphysics parametrizations available in ALADIN-HIRLAM system.

DETAILED DESCRIPTION: Basic decision is to use CAMS n.r.t. aerosol information, and to provide infrastructure enabling its exploitation in all ALADIN-HIRLAM CMCs. Ideally, design should be general enough in order to make possible future use of alternative aerosol data (e.g. from MOCAGE). Attention should be paid also to possible usage of CAMS aerosol climatology via traditional monthly climate files.

PH6.1 Preprocessing of near real time aerosol data
CAMS aerosol data are available as mass mixing ratios (MMRs) for a fixed selection of aerosol species. Because of their intended usage in both radiation and microphysics, split to these species must be kept during preparation of initial/coupling files. Therefore, the preprocessing step consists only of changing model geometry and transformation from GRIB to FA format. For this purpose, an easily portable dedicated utility must be developed and made available in an open repository. A possible candidate is the gl software currently applied for HARMONIE-AROME, which should be externalized to become available for the whole consortium. This work is connected with task SY2.10.
Anticipated usage by partners would be to set up ECMWF stream containing CAMS n.r.t. aerosol MMRs on desired domain, and adding them to initial/coupling files by running dedicated utility locally. Advantage of such solution with respect to centralized preprocessing is that telecom coupling files will remain unaffected, there will thus be no demands on their producers. Partners not interested will not get aerosol MMRs, while those interested will download them in native resolution (reduction of transferred data volume). For the high latitudes, extraction of MARS fields in rotated lat/lon geometry is the most size effective solution.

PH6.2 Implementing data flow of near real time aerosols
N.r.t. aerosol MMRs should be read from initial/coupling files as standard GFL fields. This will enable their advection and lateral coupling, as well as easy propagation across the model code, and possibly also into the output files. The goal is to pass n.r.t. aerosol MMRs to the level of APLPAR/APL_AROME, where further processing for radiation and microphysics will be done.

PH6.3 Interfacing near real time aerosols with radiation
Radiation schemes ACRANEB2 and later also ECRAD will be interfaced with externally specified aerosol optical depths and inherent optical properties. For this purpose, subroutines converting CAMS aerosol MMRs to optical properties of aerosol mixture (layer optical depth, single scattering albedo and asymmetry factor) will have to be created and inserted under APLPAR/APL_AROME. Relative humidity, that affects optical properties of hydrophilic aerosols, will be taken into account. Calculations will have to be done using spectral division that covers all assumed radiation schemes. Radiation schemes will have to be adapted so that they do not diagnose aerosol optical properties internally, but rely on externally specified values for the resulting aerosol mixture instead of individual aerosol types. The highest priority task is the adaptation of ACRANEB2. HIRLAM experience obtained using HLRADIA scheme in h-codes can be readily used for this. A simplified approach is suggested for the present default IFSRADIA (of cy25) while ECRAD may already be adapted to CAMS aerosol use.

PH6.4 Interfacing near real time aerosols with cloud microphysics
Cloud-precipitation microphysics needs cloud condensation nuclei (CCN) and ice forming nuclei (IFN) concentration numbers. Concentration number of each CAMS aerosol type will be obtained from its MMR, using assumed size distribution. Then they will be summed up to get CCN and IFN concentration numbers. This will be done by a new subroutine inserted in APLPAR/APL_AROME. Only these two fields will be passed deeper to microphysics. The effective/equivalent radii of cloud particles for the radiation schemes may be calculated from the cloud particle distributions, estimated by the microphysics parametrizations.

PH6.5 Updating monthly aerosol climatology using CAMS data
The goal is to accommodate 2D aerosol MMR fields of CAMS reanalysis climatology in the monthly climate files. These 2D fields will enter model via initial file, and after reconstructing 3D aerosol MMRs (assuming idealized vertical profiles) they will be used in radiation and microphysics in the same way as n.r.t. aerosol MMRs. Climatological MMRs will not be a subject to advection and lateral coupling. HIRLAM experience in producing the climatological 2D fields for monthly climate files can be applied.

PH6.6 Validation and testing
Extensive model-observation intercomparisons for biomass burning, mineral dust intrusion, anthrophogenic and volcanic emission case studies will be carried out, in order to evaluate aerosol impact on local weather. Direct aerosol effects can be evaluated with different radiation schemes, preferably using the more advanced ones. The task will start extensively after completion of PH6.1–PH6.3(6.4), most probably after 2021.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH6.1	Preprocessing of near real time aerosol data (see also SY2.10)	(JaMa),YaSe,UlAn	code
PH6.2	Implementing data flow of near real time aerosols	YaSe, DMP,MoMo, ABAM	code
PH6.3	Interfacing near real time aerosols with radiation	JaMa,EmGl,LaRo,KPN, PiSe, AnSl	code
PH6.4	Interfacing near real time aerosols with cloud microphysics	YaSe,KIl,DMP, PiSe, MoMo,AbAm,HaDh, RBR	code
PH6.5	Updating monthly aerosol climatology using CAMS data	LaRo, UlAn, PiSe	code
PH6.6	Validation and testing	all participants of PH6	report

t-code deliverables

Task	Responsible	Cycle	Time
PH6.1	UlAn		2021
PH6.2	DMP		2021
PH6.3			2021?
PH6.4	YaSe		2021? (after PH6.2 is ready)
PH6.5	LaRo		2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH6.1		To be defined in SY2.10	2021

ALADIN/HIRLAM/LACE WorkPackage description : PH7

WP number	Name of WP
PH7	NEW !!! Develop approaches for 3D physics
WP main editor	**Claude Fischer, Sander Tijm, Jan Masek**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
RaHo, REK	Rachel Honnert, Ryad El Khatib (CNRM/GMAP), PhD student (4 months	Météo-France	8
DiRi	Didier Ricard (CNRM/GMME)	Météo-France	4
BeHS, KPN	Bent Hansen Sass, Kristian Pagh Nielsen	DMI Denmark	1.25

WP objectives

The goal is to prepare for, and enable the use of three-dimensional effects in the physics parametrizations of the 3 CSCs. These 3D effects are indeed felt important for increasing the model realism and performance at hectometric scale. 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. The physics-dynamics interface may need to be adapted to permit this.
The effort has to be declined into two complementary directions: scientific and technical. On the scientific side, two main parametrizations are considered: turbulence for enabling horizontal mixing in addition to vertical mixing, and radiation for enabling shadowing effects. On the technical side, the implementation of horizontal mixing in the turbulence schemes will follow two distinct designs (one for AROME based on explicitly using horizontal derivative terms in the low level codes, and computing mixing within the SL stencil) and one for ALARO (based on using the SLHD approach and parameter tuning). Consistency will have to be checked: scientific one (to be defined !?); data flow and opportunity for code mutualization. "Ideally", the various scientific and technical ideas should be exchangeable across CSCs.
For radiation 3D effects are also important. Shadowing of clouds can be present over very large distances, especially when the sun is low over the horizon. It is not clear how to handle this but it is important to think about it when we look at 3D physics.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH7.1	3D turbulence solution in the AROME/ARPEGE/IFS code structure: the so-called "fullpos solution" consists in passing the horizontal gradients down to APL_AROME, in order to implement two schemes of increasing complexity (see next two tasks)	RaHo, REK	t-code, documentation
PH7.2	Increase the mixing into the cumulus deep clouds by adding turbulence terms from **Moeng et al. (2010)**. See also Verrelle et al. (2015)	DiRi	t-code, documentation
PH7.3	**Göger et al. (2018)** propose an extension of the 1D prognostic TKE equation used in the COSMO model turbulence scheme, in order to add the full three-dimensional effects in the shear production term	PhD student, RaHo	t-code, documentation
PH7.4	Technical code work in preparation for implementing the Méso-NH 3D turbulence scheme consistently in AROME and Méso-NH	?	t-code, documentation
PH7.5	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	non-t-code, report
PH7.6	Study 3D effects of radiation, shadowing effects and/or multi grid approaches	BHS, KPN	report

t-code deliverables

Task	Responsible	Cycle	Time
PH7.1	RaHo	CY48T1	end 2020 / 2021
PH7.2	DiRi	?	2021 ?
PH7.3	RaHo	?	2021 ?
PH7.4	?	?	?

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH7.[1-4]	RaHo	scientific papers as work makes progress. Probably some contribution for PH7.3 in the associated PhD work.	
PH7.5	DiRi	report	

ALADIN/HIRLAM/LACE WorkPackage description : PH8

WP number	Name of WP
PH8	NEW !!! Assess the use of ML for physics parametrizations
WP main editor	Bent Hansen Sass

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PeUk	Peter Ukkonen (2.5)	DMI Denmark	2.5
KrNi	Kristian Pagh Nielsen (0.25)	DMI Denmark	0.25
MeSh	Metodija Shapkalijavski (1)	SMHI Sweden	1
PaMe	Paulo Medeiros (1)	SMHI Sweden	1
GeBe,EmGl	Geoffrey Bessardon (1), Emily Gleeson (0.5)	MET Eireann	1.5
MiVa	Michiel Vanginderachter (0.5)	RMI Belgium	0.5
MaTu	Martina Tudor	DHMZ Croatia	0.5
BoBo, MaKo, MaSz	Bogdan Bochenek, Marcin Kolonko, Malgorzata Szczech	IMGW Poland	4

WP objectives

Machine Learning is becoming an interesting topic in NWP, not only in postprocesssing , but also in many other contexts of NWP. The potential of using Machine Learning (ML) techniques will be evaluated in physics parameterizations. Once the ML algorithms are trained they become very cheap computationally. In area's of the physics parameterizations that contain already an intrinsic uncertainty, they may help to make the model more cheap. Additionally it may be investigated whether they could be used for tuning the physics parameteriations. A good example is radiation, where crude simplications are made while the schemes themelves are very expensive. Also surface parameters and physiographic databases such as ECOCLIMAP 2nd Generation data may be improved using Machine Learning.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH8.1	In view of the fact the the ML algorithms for radiation are based on increased spectral resolution and many gases in gas optics model it is likely that the result will be an accuracy increase, and possibly a speedup. - If feasible within the time limits of 2021 this will be demonstrated for Harmonie-Arome., e.g. using outcomes from the ESCAPE-2 project	PeUk, KrNi, MiVa	Report
PH8.2	Use ML techniques to tune physical parameters , e.g. surface parameters	GeBe,MaTu,MeSh,PaMe, BoBo, MaKo, MaSz	Report and/or code
PH8.3	Use ML to improve physiographic data, e.g. ECOCLIMAP 2nd gen. data	GeBe, EmGl	Report and code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code del deliverables

Task	Responsible	Type of deliverable	Time
PH8.1	PeUk,KrNi	Report including results	December 2021
PH8.2	AnSt, GeGe,MaTu,MeSh,PaMe	Report and/or code	December 2021
PH8.3	GeBe, EmGl	Report and Code	December 2021

ALADIN/HIRLAM/LACE WorkPackage description : PH9

WP number	Name of WP
PH9	Consistency and convergence of the CSC physics
WP main editor	**Daan Degrauwe & Martina Tudor**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
PaMa, FaVo	Pascal Marquet, Fabrice Voitus	Météo-France	1
DaDe	Daan Degrauwe	RMI Belgium	2
LaRo	Laura Rontu	FMI Finland	0.5
JaMa	Jan Masek	CHMI Czech	0.25
MaTu	Martina Tudor	DHMZ Croatia	2

WP objectives

The coexistence of different canonical model configurations offers a valuable richness for research and operations, but it also requires efforts to maintain the sanity of this ecosystem. Ideally, individual parameterizations can be exchanged between the CMC's. This requires a common physics-dynamics interface and a good understanding of the relations (dependencies) between parameterizations, as well as knowledge of the validity range (in terms of resolution, but also in terms of e.g. geographical region) of the parameterizations. This work package seeks to make progress towards this ideal situation by investigating the validity ranges, by making an inventory of remaining scientific and technical blocking points for a further convergence between the CMC's, and by strengthening the foundations of the common physics-dynamics interface.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH9.1	Developing a methodology for investigation of the validity range of individual physics parameterizations and canonical model configurations (details refer to strategy document: http://www.umr-cnrm.fr/aladin/IMG/pdf/strategy.pdf)	MaTu	Documentation
PH9.2	Inventory on the scientific and technical blocking points for further convergence. Document consistency of combinations of various parameterizations schemes.	DaDe, MaTu	Documentation
PH9.3	Futher explore the thermodynamics of the way the physics parameterizations are coupled to the dynamical core. This consists of (a) theoretical research on the validity of the assumptions that are (often implicitly) made, and on the consistency between the various flavours of the dynamics (hydrostatic, anelastic, quasi-elastic, fully compressible) and the physics dynamics interface; (b) investigation of the implications in NWP; and (c) implementation in the code.	PaMa, FaVo, DaDe, MaT	Documentation, code in t-cycle (long-term)
PH9.4	Ensure consistency across CSCs between treatment of aerosols, clouds and radiation	LaRo, JaMa, MaTu	Documentation

t-code deliverables

Task	Responsible	Cycle	Time
PH9.3	DaDe	?	(depending on outcome of theoretical research)

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH9.1	MaTu	report	End 2021
PH9.2	DaDe	report	Mid 2021
PH9.3	PaMa	report	End 2021

ALADIN/HIRLAM/LACE WorkPackage description : PH10

WP number	Name of WP
PH10	NEW !!! Litterature survey of existing fully stochastic physics parametrizations
WP main editor	**Piet Termonia, Claude Fischer, Jeanette Onvlee**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
MeSh	Metodija Shapkalijevski	SMHI Sweden	1
FrBt, AxFl	François Bouttier, Axelle Fleury (PhD)	Météo-France	12
MiVa, JoVa	Michiel Vanginderachter, Joris Van den Bergh	RMI Belgium	2
WiVe	Wim Verkleij	KNMI Netherlands	2

WP objectives

Currently we have a few approaches for upper-air stochastic parameterizations in the ALH community: the cellular automata (CA) Bengtsson et al. and the physically based sampling method of Van Ginderachter et al. (2020). The first one has been tested in the code in the past. The second is far from being mature at this stage. Currently it is being explored whether the model errors can be "recognized" by machine learning techniques.The second paper also contains a brief, but recent literature review. Here we can extend that review to a more complete one. Both schemes strongly rely on the deep convection parameterization of the ALARO physics. The second approach could, in principle, be applied to turbulence. The aim of this WP is to explore the literature and to extend our R&D activities in this domain, specifically to other parameterizations than deep convection.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH10.1	Literature review on fully stochastic physics paramaterizations	MeSh, WiVe	reports
PH10.2	train ML algorithms on hind casts to reproduce model errors	MiVa, JoVa	reports
PH10.3	study several approaches for implementing some flavour of stochasticity within the physics parametrizations. Note: one ref paper is Kober & Craig (2016) for turbulence. This task references the PhD work by Axelle in the CNRM/GMME group.	AxFl, FrBt	reports

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

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	3.5
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui	Maroc Meteo	2
ÅsBa, MaHo, TrAs, YuBa, JoBl	Åsmund Bakketun (H2O*), Mariken Homleid (1.5, MetCoOp*, AROME-Arctic*), Trygve Aspelien (1.6, H2O*), Yurii Batrak (Alterness), Jostein Blyverket (H2O)	MET Norway	3
CaBi	Camille Birman	Météo-France	7
RaHa, JaDp, IdDe	Rafiq Hamdi, Jan De Pue, Idir Dehmous	RMI Belgium	
ViTa	Viktor Tarjani	SHMU Slovakia	2
PaSa, JeBo, MaLi, ToLa	Patrick Samuelsson (soil-moisture* 1), Jelena Bojarova (soil moisture* 1.5), Magnus Lindskog (MetCoOp* 0.5), Tomas Landelius (ext*)	SMHI Sweden	0
HeKo	Helga Kollathne Toth	OMSZ Hungary	3

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 (2021): 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 (2021-2022): 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	Further 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	Consider, 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.	ViTa, HeKo	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 MaHo	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. Includes bias-aware EKF.	YuBa, EkKo	t-code, code
SU1.5	Investigating the use of Land-SAF product when building the Jacobian matrix for EKF/STAEKF	RaHa, JaDp, MaHo	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. Development of pysurfex. Solve the aerosol-update now done in 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
SU1.9	Strategic and practical direction towards a strongly coupled atmosphere-surface assimilation system. Includes spatialization methods using ensembles, ability to use satellite data. Connection to BUMP (Background error on Unstructured Mesh Package). The plans and ideas are coordinated with ECMWF. See also DA2.8.	PaSa, JFMa, RoRa, DaSa, CaBi, ToLa, TrAs, RaHa, JoBl, ÅsBa	report
SU1.10	Develop an offline analysis environment based on full physics in SURFEX forced by a near-real-time analysis which provides an initial state for SURFEX variables in a new cycle.	TrAs	

t-code deliverables

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

Non-t-code deliverables

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

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 (UC INTAROS*)	FMI Finland	0
LaRo	Laura Rontu (ext*)	FMI Finland	0
JoDV	John de Vries (ext*)	KNMI Netherlands	0
MaHo	Mariken Homleid (MetCoOp*, AROME-Arctic*)	MET Norway	0
YuBa	Yurii Batrak (ext*)	MET Norway	0
TrAs	Trygve Aspelien (1.6, H2O*)	MET Norway	1.5
CaBi	Camille Birman	Météo-France	1
JaDp	Jan De Pue	RMI Belgium	
PaSa	Patrick Samuelsson (soil moisture* 1)	SMHI Sweden	0
HeKo	Helga Toth Kollathne	OMSZ Hungary	1
BaSz	Balázs Szintai	OMSZ Hungary	1
StSc	Stefan Schneider	ZAMG Austria	6
SaOs	Sandro Oswald	ZAMG Austria	0.5

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
SU2.2	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, PaSa	report, code
SU2.2.3	[SCATSAR-SWI (combined Sentinel-1 + ASCAT product)] - [sEKF] - [8.1]	StSc	publication
SU2.3	Examine available satellite sea-ice extent products and make them available in ODB. E.g. OSI SAF	YuBa, BiCh	report, code
SU2.4	Explore the possibility to use SIMBA buoys for assimilation of sea-ice conditions.	BiCh, YuBa	report
SU2.5	Examine available 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
SU2.5.4	[satellite derived skin temperature] - [2D OI in CANARI] - [AROME]	CaBi	publication
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]	EkKo, TrAs	
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
SU2.8.2	[Sentinel-2-based LAI] - [sEKF] - [8.1] daily updated LAI for Austria	StSc, SaOs	publication
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
SU2.2.3	StSc	publication	End of 2020
SU2.3	YuBa	report, script changes	End 2023
SU2.4	BiCh	report	End 2021
SU2.5.1	RaHa	tbd	2020/2021
SU2.5.2	StSc	report	Q2 2021
SU2.5.4	CaBi	publication	End 2021
SU2.6	TrAs	report	End 2021
SU2.7.2	LaRo	report	End 2021
SU2.8.1	BaSz	report	End 2021
SU2.8.2	StSc	publication	End 2022
SU2.9.1	JoDV	report	End 2021

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 Ján Mašek**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
SaVi	Samuel Viana	AEMET Spain	2
SuPa	Suzana Panežić	DHMZ Croatia	1
OlSa	Olli Saranko (HERCULES*)	FMI Finland	0
SiTh	Sigurður Þorsteinsson	IMO Iceland	1
JodVr	John de Vries	KNMI Netherlands	2
MaHo, TrAs, ÅsBa	Mariken Homleid (1), Trygve Aspelien (0.8, H2O*), Åsmund Bakketun (H2O*)	MET Norway	1.75
EmGl	Emily Gleeson	MET Eireann	1
PaLM, AaBo, MaMi	Patrick Le Moigne, Aaron Boone, Marie Minvielle : CNRM/GMME	Météo-France	22
YaSe, GhFa, CaBi, AdNa	Yann Seity, Ghislain Faure, Camille Birman, Adrien Napoly : CNRM/GMAP		
OuDo	Oussama Douba	ONM Algeria	3
RaHa, JaDp, FrDu, StCa, NiGh	Rafiq Hamdi (4), Jan De Pue (4), François Duchene (3), Steven Caluwaerts (1), Nicolas Ghilain	RMI Belgium	12
PaSa, JeBo, KIIv, DaBe	Patrick Samuelsson (1.25), Jelena Bojarova (0.25), Karl-Ivar Ivarsson (0.25), Danijel Belusic (climate projects*)	SMHI Sweden	1.75
StSc, FlWe, ChWi, FlMe	Stefan Schneider, Florian Weidle, Christoph Wittmann, Florian Meier	ZAMG Austria	6
MaDi	Martin Dian	SHMU Slovakia	4
JaMa	Ján Mašek	CHMI Czech	2

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 are in principle available from SURFEXv8/cy43, i.e. including e.g. diffusion soil scheme (DIF), multi-layer explicit snow scheme (ES), although the SURFEX team only recommend use of these componenets from SURFEXv8.1 and onwards. Please note, Multi-Energy Budget (MEB) is only available from v8.1. The DIF scheme also offers a number of hydrological options. Precisely, cy43t includes SURFEXv8.0 and cy43h includes SURFEXv8.1. 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.

Similar versions of these components are operational in the latest release of the HIRLAM model and have provided increased skill over certain areas. For HIRLAM NWP, in cy43h, we now have the new physicis componenets in ISBA of SURFEXv8.1, mainly ES, DIF, MEB running.

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).

The more advanced surface physics componenets are relevant and applied by the ALADIN-HIRLAM climate modelling community. E.g. HCLIM is now active in use and development of cy43h for climate modelling and they will continue to idently biases and suggest improvements that can be directly beneficial for the NWP community. Please refer to HCLIM Rolling Work Plan here: https://docs.google.com/document/d/15EleJmdloUcRDQGnPEXoTmYUB4b0zszMxfHQjRFn6l4/edit?usp=sharing

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).	SaVi, PaSa, MaHo, EmGl, JodVr, TrAs, PaLM, AaBo, MaMi, YaSe, OuDo, CaBi, RaHa, JaDp,FrDu,StCa, FlWe, ChWi, FlMe	see subtasks
SU3.1.1	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, EmGl, JodVr, TrAs, 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, EmGl, JodVr, TrAs, PaLM, AaBo,FlWe, ChWi, FlMe	configuration, t-code
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	Activate TEB in kilometric NWP AROME/ALARO runs and in climate runs. Examine the potential use of, until now, non-utilized options in TEB.	RaHa, StCa 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
SU3.7	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, KlIv, (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 PH2.7.	MaHo, DaBe, SiTh	
SU3.12	Evaluate prognostic LAI (A-gs) for HARMONIE-AROME, AROME and ALARO	JaDp, NiGh, ...	
SU3.13	Coupling to hydrological processes (OASIS-TRIP)		

t-code deliverables

Task	Responsible	Cycle	Time
SU3.1.2	SaVi	SURFEX code contributions, namelist changes	End 2021
SU3.2	JodVr	SURFEX code contributions	End of 2021
SU3.8	(SuPa), JaMa	SURFEX code contributions	Autumn 2021
SU3.9	MaDi, JaMa	SURFEX code contributions	Autumn 2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU3.1.1	SaVi	report	End 2021
SU3.2	JodVr	script changes, namelist changes	End 2021
SU3.3	OlSa	report, namelist changes	End 2021
SU3.4	StSc	report	End 2021
SU3.5	GhFa	report	
SU3.7	SaVi	report, namelist changes	End 2021
SU3.8	SuPa	report	End 2021 (if not finished in 2020)
SU3.9	MaDi	report	End 2021

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	Laura Rontu (1)	FMI Finland	1
BoPa	Bolli Palmason	IMO Iceland	1
YuBa	Yurii Batrak (Alterness*, AROME-Arctic*, FOCUS*)	MET Norway	0
AaBo	Aaron Boone : CNRM/GMME	Météo-France	4
PaSa, MeSh	Patrick Samuelsson (2), Metodija Shapkalijevski (1)	SMHI Sweden	3
EmGl	Emily Gleeson	MET Eireann	1
RaHa,JaDP	Rafiq Hamdi, Jan De Pue	RMI Belgium	
SaVi	Samuel Viana	AEMET Spain	2.5

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, orography related radiation (ORORAD) 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, new laternatives for surface-layer turbulence formulation. 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	t-code
SU4.3	Evaluate the orographic radiation (ORORAD) implementation in cy46h and apply further modifications and developments. Probabaly update SURFEX in cy46h to SURFEXv9 (which would include ORORAD).	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
SU4.7	Improvement of the phenology in ISBA-Ags.	RaHa, JaDP	t-code
SU4.8	New roughness formulation, including blendning height, in SURFEX including the displacement height concept.	SaVi, MeSh, JodVr	
SU4.9	In SURFEXv8.1 of SODA the EKF algorithms are tightly connected to the ISBA tile. However, algorithms and tiles should be separated from each other. Work on this is ongoing initiated by sea-ice-EKF development.	YuBa	
SU4.10	New surface layer turbulence a la Niels Woetmann Nielsen.	KPNi	
SU4.11	Investigate problem related to non-melting of thin snow layers (too stable over snow preventing sensible heat flux from above).	MeSh	t-code

t-code deliverables

Task	Responsible	Cycle	Time
SU4.1	BoPa	SURFEX code contributions	End 2021
SU4.2	YuBa	SURFEX code contributions	End of 2021
SU4.3	LaRo	SURFEX code contributions	End of 2021
SU4.5	PaSa	SURFEX code contributions	End of 2020
SU4.7	RaHa	SURFEX code contributions	End of 2020
SU4.8	MeSh	SURFEX code contributions	End 2022
SU4.9	YuBa	SURFEX code contributions	End 2022

SU4.10	KpNi	SURFEX code contributions	End 2021
SU4.11	MeSH	SURFEX code contributions	End 2021

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	1.5
EkKo, OlSa	Ekaterina Kourzeneva (1), Olli Saranko (HERCULES*)	FMI Finland	1
BoPa	Bolli Palmason	IMO Iceland	2
JodVr	John de Vries	KNMI Netherlands	1
PaSa	Patrick Samuelsson	SMHI Sweden	1
StSc, SaOs	Stefan Schneider, Sandro Oswald	ZAMG Austria	2.5
DuUs	Duygu Üstüner	MGM Turkey	3
KaSa	Kai Sattler	DMI Denmark	1
EmGl, GeBe	Emily Gleeson (ext*), Geoffrey Bessardon (ext*)	MET Eireann	0
DiTz, FlSu	Diane Tzanos, Florian Suzat	Météo-France	6

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. Examining for ALADIN countries and Spain. Studying of urban areas. Improving ECOCLIMAP over China.	BoPa, EkKo, PaSa, TeVa, SaTi (in frames of QA), DuUs, StSc, SaOs	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, EkKo, PaSa, MaHo, TeVa, SaVi, ??? + SaTi (in frames of QA), FlSu	database, reports, documentation, code
SU5.3	Tree height data activities. Identify and apply suitable combinations of tree height data.	MaHo, TeVa, PaSa	report, code
SU5.4	Lake database (GLDB) Participate in GLDB developments and studying the impact.	EkKo, BoPa	database, code, reports
SU5.5	ECOCLIMAP SG activities. Examining and participate in developments	TeVa, SaVi, JodVr, EkKo, OlSa, EmGl, DiTz, KaSa	report
SU5.7	Tools, and their documentation, for handling of physiography data.	GeBe, BoPa, EmGl	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU5.1	BoPa	updated databases, related h-code, reports	End 2021
SU5.2	BoPa	updated databases, related h-code, reports	End 2021
SU5.3	MaHo	report	End 2021
SU5.4	EkKo	report, updated databases, related h-code if necessary	End 2021
SU5.4	EkKo	report	End 2021

SU5.5	TeVa	report	End 2021
SU5.7	GeBe	report	End 2021

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
SyMa, LaCo, SoBi, CiLB, MNBo	Sylvie Malardel, Laetitia Corale (PhD), Soline Bielli (SRNS), Cindy Lebeaupin-Brossier (MF/CNRM), Marie-Noëlle Bouin (MF/CNRM)	Météo-France	10
MaLi, PeSm, AnFe, JuCe	Matjaž Ličer, Peter Smerkol, Anja Fettich	ARSO Slovenia	3
ErTh, NiSz, MaMu, CyPa, YuBa	Erin E. Thomas (xxpm, external project), Nicholas Szapiro (xxpm, external project), Malte Müller (1pm, external project), Cyril Palerme (xxpm, external project), Yurii Batrak (xxpm, external project)	MET Norway	
BaKSa	Basanta Kumar Samal (SEAI (Sustainable Energy Authority Ireland)*)	MET Eireann	

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 (ARSO) 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 in 2019 and ALARO is going to use SURFEX, the coupling should be redone via SURFEX-OASIS. First coupling ALARO with WAM should be implemented, after NEMO can be added.

A coupled configuration AROME-NEMO has been implemented in 2020 at LACy (Laboratoire de l'Atmosphère et des Cyclones, joint centre between University of La Réunion, Météo-France and CNRS) for the Indian Ocean configuration of AROME. The coupling is made by OASIS through SURFEX. The oceanic model is initialized and coupled at the lateral boundaries by the MERCATOR analysis. Its validation is ongoing and is using a series tropical cyclones of the 2018-2019 season. The coupling of the AROME-NEMO configuration with the wave model WW3 is work in progress and will be validated in 2021. At LACy, the coupling with the waves will mainly be used for the development and testing of new flux parametrisations at the air-sea interface in case of extreme winds (TC).

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, in different configurations, of the HARMONIE-AROME with wave model WW3, sea-ice model CICE, ocean model ROMS and ocean 1D model GOTM in cy43. Ireland is working on coupling Harmonie-AROME with WW3 and target to make it operational for Ireland region by 2021. Further plans are to couple with ROMS ocean model (AROME-WW3-ROMS).

The ALADIN-HIRLAM climate modelling community has quite some activities in the area of coupling to other componenets like wave/ocean and routing/hydrology, including the coupling technic via OASIS. E.g. please refer to the HCLIM Rolling Work Plan here: https://docs.google.com/document/d/15EleJmdloUcRDQGnPEXoTmYUB4b0zszMxfHQjRFn6l4/edit?usp=sharing

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU6.1	Set-up of coupled system AROME-WW3-NEMO		
SU6.1.1	Validation of the set-up AROME-NEMO within cy43	SyMa, LaCo, SoBi, CiLB, MNBo	t-code
SU6.1.2	Development and validation AROME-WW3-NEMO	SyMa, LaCo, SoBi, CiLB, MNBo	t-code
SU6.2	Set-up of coupled system ALARO-WAM-NEMO		
SU6.2.1	Development and validation of an ALARO-WAM setup	MaLi, PeSm, AnFe	
SU6.2.2	Development of ALARO-WAM-NEMO	MaLi, PeSm, AnFe	
SU6.3	Development and set-up of coupled system HARMONIE-AROME-OASIS- in different configurations		
SU6.3.1	Wave model -WW3. With operational NWP application in mind.	BaKSa, ErTh	t-code
SU6.3.2	Also with ocean model and sea-ice model -WW3-ROMS-SICE in Norway	ErTh, NiSz, MaMu, CyPa, YuBa, BaKSa	t-code
SU6.3.3			

t-code deliverables

Task	Responsible	Cycle	Time
SU6.1.1	SyMa	cy48t1	Begin 2021

SU6.1.2	SyMa	cy??	??
SU6.2.1	PeSm	cy43	End 2021
SU6.3.1	BaKSa	cy43	End 2021
SU6.3.2	MaMu, BaKSa	cy??	End 2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU6.2.1		report	summer 2021
SU6.2.2		report	End 2021

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	45
FrBt, HuMa, SaRa	François Bouttier, Hugo Marchal : CNRM/GMME	Météo-France	21
OlMe, MiZa, MaTa	Olivier Mestre, Michael Zamo, Maxime Taillardat : DirOP/COMPAS	Météo-France	9
MoJi	Mohamed Jidane	Maroc Meteo	1

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, 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 & documentation
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 other Arome models (Overseas, Morocco). Exploring specific topics for such specific EPS's (perturbation strategies, impact of specific tunings, evaluation on tropical cyclone predictability)	OlNu, GhFa, MoJi	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. Comment: the work on SPP is part of Meryl Wimmer's PhD	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	Janne Kauhanen	FMI Finland	3
KaHa	Karoliina Hamalainen	FMI Finland	3
ScdV	Sibbo van der Veen	KNMI Netherlands	3
WdR	Wim De Rooy	KNMI Netherlands	0.75
ArTs	Aristofanis Tsiringakis	KNMI Netherlands	2
AlHa	Alan Hally	MET Eireann	2.5
ILF	Inger-Lise Frogner	MET Norway	3
TeVa	Teresa Valkonen (* Alertness)	MET Norway	0
GeSm	Geert Smet	RMI Belgium	1
MiVa	Michiel Vanginderachter	RMI Belgium	2
UlAn	Ulf Andrae	SMHI Sweden	2

WP objectives

Study ways to represent uncertainty in the atmospheric model and how to best incorporate this into HarmonEPS.
-The SPPT scheme will be further optimized.
-The SPP approach (Stochastically Perturbed Parametrization scheme) will be further developed.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.1.1	SPPT: Look into new ways of constructing SPPT. Perturbing independently each parameterisation will be prioritized, as it would probably allow for removing the tapering in the PBL by switching of SPPT for turbulence.	AlHa, JaKa, KaHa	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, by adding more parameters to the scheme and adjusting individually the parameter pdf's. The SPG pattern generator will be further tested as well as correlated patterns for some parameters. SPP will be adapted to new physics (e.g LIMA and ec-rad). 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, ArTs	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E2.1.1	AlHa	cy43h then in t	End 2021
E2.1.3	UlAn	Redesigned in cy48	

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.1.2	GeSm	HarmonEPS configuration test (namelist changes)	End 2021

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	1
ILF	Inger-Lise Frogner	MET Norway	1
RoRa	Roger Randriamampianina (* Alertness)	MET Norway	0
JeBo	Jelena Bojarova	SMHI Sweden	2
MaLi	Magnus Lindskog	SMHI Sweden	0.5

WP objectives

EDA will be developed further in 2021. LETKF, EDA and perturbations to the whole control vector (Brand) will be tested and compared. The ensemble should be suitable for data assimilation purposes, and special attention will be payed to this in 2021.

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	Comparison of ensemble performance with different types of initial conditions perturbations within variational or hybrid ensemble variational data assimilation framework will continue : EDA, LETKF, forcing perturbations and BRAND perturbations, with emphasis on probabilistic verification and size of the ensemble. 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 available and non-tested optimizations in LETKF code.	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.	JeBo	t-code
E2.2.4	NEW: The ensemble should be suitable for data assimilation purposes, investigating the impact ensemble generation techniques have on sampling of the climatological as well as error-of-the-day covariances (see also DA1.1)	ILF, UlAn, MaLi	Non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E2.2.1	ILF and RoRa	HarmonEPS configuration test	End 2021
E2.2.2	JeBo	optimal configuration of the variational EPS system	?
E2.2.3	JeBo, PaEs		2022
E2.2.4	ILF	HarmonEPS configuration test	2022

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	0.5
JdV	John de Vries	KNMI Netherlands	2
AnSi	Andrew Singleton	MET Norway	1
HaMc	Harold McInnes	MET Norway	7
RaGr	Rafael Grote (* Alertness and APPLICATE)	MET Norway	0
DaYa	Daniel Yazgi	SMHI Sweden	
JeMo	Jennie Molinder (* PhD)	SMHI Sweden	0
GeSm	Geert Smet	RMI Belgium	1

WP objectives

Refine the surface perturbations and make them more realistic, include perturbations to the surface physics.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E2.3.1	Revise soil moisture perturbations, as the current formulation often leads to a drying of the perturbed members. 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, this work will continue in 2021. 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.	RaGr, HeFe, GeSm, JeMo, HaMc, DaYa	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, DaYa	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		2022
E2.3.2	AnSi		2022
E2.3.3	JeBo		?

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : E2.4

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
HeFe	Henrik Feddersen	DMI Denmark	0.5

WP objectives

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 as 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
E2.4.3	The humidity perturbations will be studied closer and we will investigate methods that don't lead to unrealistic dry conditions.	HeFe	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 2021
E2.4.3	HeFe	configuration	End 2021

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	Ole Vignes	MET Norway	1
UlAn	Ulf Andrae	SMHI Sweden	1

WP objectives

Provide continuous support for the implementation of new HarmonEPS developments.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
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
E2.5.4	OlVi	CY47t1 ? CY48-49?	2021?

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
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
ViHo	Viktoria Homonnai	OMSZ Hungary	1
KJR	Katalin Javorne Radnoczi	OMSZ Hungary	6
ClWa	Clemens Wastl	ZAMG Austria	7.5
FlWe	Florian Weidle	ZAMG Austria	1
EnKe	Endi Keresturi	DHMZ Croatia	1.25
AlGu	Alper Güser	MGM Turkey	3

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	Improve uncertainty representation of surface processes in convection permitting C-LAEF system (e.g. new perturbations, new methods)	ClWa	t-code
E3.2	Improve stochastic parameter perturbations (SPP) with special focus on convective hazards (e.g. processes in microphysics).	ClWa, EnKe	t-code
E3.3	Optimization and tuning of operational AROME based EPS system C-LAEF on cy43t2 at ECMWF HPC.	FlWe, ClWa	non-t-code
E3.4	Introduction of ensemble data assimilation into convection-permitting ensemble system at OMSZ. Continuous tuning and optimization.	ViHo, KJR	non-t-code
E3.5	Adaptation of C-LAEF to Turkish Domain	AlGu	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
E3.1	ClWa	CY43T2	2021
E3.2	ClWa	CY43T2	2021

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E3.3	FlWe, ClWa	scripts, verification results	2021
E3.4	ViHo, KJR	scripts, verification results	2021
E3.5	AlGu	report, scientific study	2021

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
MaBe	Martin Belluš	SHMU Slovakia	9
MaIm	Martin Imrisek	SHMU Slovakia	1
MaDe	Maria Derkova	SHMU Slovakia	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	MaIm	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	t-code
E4.3	Preparation of flow-dependent B-matrix using the ALADIN-LAEF 5km operational outputs.	MaBe	non-t-code
E4.4	Operational implementation of ALADIN-LAEF 5km Phase II configuration involving ENS BlendVar to improve the simulation of upper-air ICs uncertainty	MaBe, MaDe	non-t-code

t-code deliverables

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

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E4.3	MaBe	scripts, reports, evaluation study	2021
E4.4	MaBe, MaDe	scripts, different probabilistic products	2021

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	0.5
KiWh	Kirien Whan	KNMI Netherlands	2
MaSc	Maurice Schmeits	KNMI Netherlands	1
EmSa	Emine Say	MGM Turkey	2
JBB	John Bjørnar Bremnes (* also ext MetCoOp)	MET Norway	2

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, EmSa	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	2021
E6.2	JBB	Calibration code	2021

ALADIN/HIRLAM/LACE WorkPackage description : E7

WP number	Name of WP
E7	NEW !!! Develop user-oriented approaches
WP main editor	**Claude Fischer, Martina Tudor, Jeanette Onvlee, Piet Termonia**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
GeSm, JvdB	Geert Smet, Joris van den Bergh	RMI Belgium	1
HeFe	Henrik Feddersen	DMI Denmark	1
CeAm, LaRa, ArMo, LuRo, MaPl	Cédric Amoré, Laure Raynaud, Arnaud Mounier, Lucie Rottner, Matthieu Plu, + PhD (coll. IRSN)	Météo-France	17
ChWi, ClWa, FlWe, ChZi	Christoph Wittmann (1), Florian Weidle (0.5), Christoph Zingerle (1)	ZAMG Austria	2.5
SiVe	Sibbo vd Veen	KNMI Netherlands	1
SiTa	Simona Tascu	Meteo Romania	2
AkJo, DaYa	Åke Johansson (1) and Daniel Yazgi (1)	SMHI Sweden	2
AlCa, MaCo, DaQu	Alfons Callado-Pallarés (0.5), Maria Cortes (0.5), David Quintero (0.5)	AEMET Spain	1.5
EnKe, IrOd	Endi Keresturi, Iris Odak Plenković	DHMZ Croatia	4.25

WP objectives

Ensemble outputs, also after improvement thanks to statistical calibration, provide reliable and sharp probabilistic forecasts. Although it is acknowledged that probabilistic forecasts are more skilful than deterministic ones, experience in different meteorological centres shows that the use of probabilistic forecasts is still not common. A major reason is the difficulty to communicate meaningful probabilistic forecasts out of the ensemble (Fundel et al, 2019), in a way that suits the users' needs. As a consequence, methods that bridge the gap with end-user applications and that facilitate the use of ensemble are needed. This theme include the development of methods that: (i) facilitate the *decision-making of end users* of probabilistic forecasts for early warnings of severe weather, and for assessing and communicating the uncertainty of the forecast, and (ii) demonstrate the *added value of ensemble outputs* for meteorologically sensitive domains of application, such as transport, agriculture, energy, etc. Methods issued from Artificial Intelligence can be explored to achieve such goals. Generic approaches are sought.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E7.1	Detection of precipitation objects in ensemble, use for evaluation, visualisation, neighbouring. Detection of texture of precipitation. Objective identification of convection objects and of severe storms, using deep NN, clustering and evaluation against radar data, upscaled probabilities	ArMo, LaRa, LuRo, MaPl, FlWe	scientific publication, trained neural network for storm detection from AROME
E7.2	Early warnings of severe rainfall and severe wind, including Extreme Forecast Index (EFI) and Shift of Tails (SOT). Verification of ensemble forecasts targeted for early warning guidance to forecasters (Contrib. DMI - ZAMG). Assess EFI product for 1.3km resolution EPS & reforecast dataset (Contr. MF)	HeFe, CeAm, LaRa, MaPl, ChZi, AlCa	
E7.3	Development of decision making criteria for renewable energy: power cut outs, solar energy production probabilistic forecast (SMART4RES).	GeSm, LaRa	report
E7.4	Development of decision making criteria for agriculture: ...		
E7.5	Development of decision making criteria for hydrological applications: ...	JvdB	
E7.6	Development of decision making criteria for transportation safety (road, aviation, ..)	JvdB, AkJo, DaYa, SiVe, ChWi, ChZi	
E7.7	Development of decision making criteria for Tourism, Event support (e. g. festivals, sport events, etc.)	ChWi, ChZi	
E7.8	Use of ensemble forecasts for emergency dispersion modelling (nuclear or chemical): The objective is to design a small ensemble from PEARO members that would be used as input data of atmospheric dispersion models for emergency situations. Calibration, time junction, and clustering will be investigated to build relevant scenarios for users.	LaRa, MaPl, PhD	scientific publication
E7.9	Precipitation, snow and wind/gust maximum in a variable radius, based on LAM-EPS uncertainty; specific airports calibrated EPSgramms; developing a calibration on extremes for classical parameters as temperature, wind and precipitation (in the framework of Eumetnet / SRNWP-EPS)	AlCa, MaCo, DaQu	
E7.10	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	non-t-code
E7.11	Creation of new ALADIN-LAEF probabilistic products to meet the different users requirements that require technical solutions, new fullpos fields (and grib coding) and minimize the required data traffic	MaBe, SiTa, EnKe	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E7.[1,2,8]	MaPl	for any deliverable of this list of tasks	
E7.3	LaRa	public SMART4RES EU project deliverables, scientific publication	

ALADIN/HIRLAM/LACE WorkPackage description : MQA1

WP number	Name of WP
MQA1	Development of HARP
WP main editor	**Christoph Zingerle, Bent Hansen Sass**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
BHS	Bent Hansen Sass (0.25)	DMI Denmark	0.25
AlDe	Alex Deckmyn (3 pm)	RMI Belgium	3
AnSi	Andrew Singleton (4 pm)	MET Norway	4
LeØs	Lene Østvand (1 pm)	MET Norway	1
ChZi	Christoph Zingerle (1 pm)	ZAMG Austria	1
FiSv	Filip Švábik	CHMI Czech	2

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
MQA1.1	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. A specific Web-meeting will be organized with emphasis on User needs and next developments for harp.	AlDe, ChZi, AnSi,BeSa, FiSv	documentation, code, meetings, User training events
MQA1.2	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, AnSi, BeSa, LeØs	code
MQA1.3	Implementation in harp of the developments in WP MQA2 (development of new verification methods/metrics – spatial verification of EPS's) and score cards	AlDe, ChZi, Ansi, BeSa	code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
MQA1.1	AlDe, ChZi,AnSi	Extended documentation, examples and tutorials will be available and updated continuously.	2021
MQA1.2	AlDe, ChZi,AnSi	Code update for harp, tools for deterministic, EPS and spatial verification are available. They are successively integrated in the existing code v3.	2021
MQA1.3	AlDe, ChZi,AnSi	Code for spatial tools for EPS will be available in the same manner as for the spatial and EPS parts.	2021

ALADIN/HIRLAM/LACE WorkPackage description : MQA2

WP number	Name of WP
MQA2	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,CaPe	Bent Hansen Sass, Henrik Feddersen, Carlos Peralta (1.75, 2, 1.5)	DMI Denmark	5.25
GeMo	Gema Morales (1)	AEMET Spain	1
GeGe,PiWa	Gertie Geertsema (2.25) , Ping Wang (1)	KNMI Netherlands	3.25
AlDe	Alex Deckmyn (1)	RMI Belgium	1
JoSt, MaJe, FaSt	Joël Stein, Fabien Stoop : DirOP/COMPAS	Météo-France	4
DaYa	Daniel Yazgi (1.5)	SMHI Sweden	1.5
ChZi	Christoph Zingerle (1)	ZAMG Austria	1
BoTs	Boryana Tsenova	NIMH Bulgaria	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 . 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 OCTAVI (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 (QA2.4). NB: Verification methods for probabilistic forecasts of high-impact, rare events are developed in OCTAVI and HARP. It is in 2021 moved to work task E7 having a focus on results to be used to develop an associated guidance to duty forecasters. The further development of a tool to generate MSG simulated SEVIRI images is described in QA2.5. 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.2.6.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
MQA2.1	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
MQA2.2	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
MQA2.3	Include new metrics to characterize forecast errors both in space and time, e.g. relative to ECMWF or HARMONIE analysis . Develop this in spatial verification context for ensembles. Transfer developments to HARP for operational use. "Spatial agreement score" and " SLX" are candidates for such implementation (DaYa,Hefe,Besa,AlDe).	HeFe, BeSa, AlDe, DaYa	Develop and test code, document results (common code for HIRLAM and ALADIN)
MQA2.4	Further development of Score Card concept , including adaptation to harp (CaPe) - Extend score cards to new verification parameters, e.g. mixing height, and/or measures for spatial verification and probabilistic verification.	CaPe, GeMo,GeGe, JoSt, FaSt	Scripts/code (common code for HIRLAM and ALADIN) and associated results of new developments
MQA2.5	Further development of tool to generate and present MSG SEVIRI simulated radiance data	PiWa	Code, user documentation, validation study
MQA2.6	New neigborhood-based methods are applied to the verification of ensemble forecasts to allow the comparison of deterministic and ensemble forecasts	JoSt, FaSt	Code, validation study in a peer-reviewed publication
MQA2.7	Investigation, probably with neighborhood-based methods, of: - the relationship between AROME-BG microphysics and lightning data from ATDnet (available data since 2018) - AROME-BG precipitation verification based on automatic stations data.	BoTs	Reporting

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
MQA2.1	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.	?
MQA2.2	ChZi, AlDe	Prototype code to be implemented in HARP for spatial-EPS verification (Q1.6)	?
MQA2.3	HeFe, BeSa, AlDe, DaYa	Develop and test code, document results (common code for HIRLAM and ALADIN)	Dec 2021
MQA2.4	CaPe,GeGe, JoSt, FaSt	scripts/code (common for HIRLAM-ALADIN) and results	June 2021 ?
MQA2.5	PiWa	Code and Validation	Dec 2021 ?
MQA2.6	JoSt, FaSt	publication in international review	June 2021

ALADIN/HIRLAM/LACE WorkPackage description : MQA3

WP number	Name of WP
MQA3	Meteorological 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 (2)	AEMET Spain	2
BeSa,XiYa	Bent Hansen Sass, Xioahua Yang (3.75,0.25)	DMI Denmark	4
MaKa, EeSa	Markku Kangas	FMI Finland	2
SaTi, WiRo, PiWa	Sander Tijm, Wim de Rooy, Ping Wang (0.25 , 1.0, 1.0)	KNMI Netherlands	2.25
EmGl	Emily Gleeson (1.0)	MET Eireann	1
RoRa	Roger Randriamampianina (0.25)	MET Norway	0.25
AhMe, IvAn ,SuTo	Ahto Mets , Ivar Ansper, Sulev Tokke (2.0, 0.5, 0.5)	ESTEA Estonia	3
KaIv,PaSa	Karl-Ivar Ivarsson (0.5), Patrick Samuelsson (0.25)	SMHI Sweden	0.75
HaDh,RaRo	Hajer Dhouioui (1), Rahma Ben Romdhane (1)	INM Tunisia	2
MaPe	Martin Petras (2)	SHMU Slovakia	2
MaDe	Maria Derkova (0.25)	SHMU Slovakia	0.25
MaJe, FaSt,JMVi, FrPo,YaPr	Marine Jeoffrion, Fabien Stoop, Jean-Marie Willemet, Francis Pouponneau, Yann Prigent : DirOP/COMPAS (4)	Météo-France	14
YvBo, FrBo, GhFa, OlNu, CeLo, PaMa, LoBe, HaPe, others: GMAP	Yves Bouteloup, François Bouyssel, Ghislain Faure, Olivier Nuissier, Cécile Loo, Pascal Marquet, Loïk Berre, Harold Petithomme, other colleagues from GMAP when needed	Météo-France	30
FlMe, FlWe, ChWi	Florian Meier, Florian Weidle, Christoph Wittmann	ZAMG Austria	2.5

WP objectives

The goal of this work package is to secure the meteorological quality of the CSCs in order to be competitive with other world class NWP forecasting systems. To achieve this a number of tasks are needed which aim at a detailed verification and diagnosis regarding skills and deficiencies of operational systems. Also impacts of proposed upgrades based on the results from other work packages in the RWP, e.g regarding improved formulation of physics, dynamics and data-assimilation, will be investigated in order to recommend which upgrades which upgrades should be implemented in the next common model cycle(s). - The scope of the work package differs from the technical validation of new model cycles that are under strong time constraints and - as a consequence - includes only some standard meteorological scores and a limited subjective evaluation.

The work tasks below are executed by the different CSCs according to their decisions and coordinated. The work package needs several types of tasks in order to contain the necessary activities to secure adequate development of the meteorological quality of the CSCs:
The task MQA3.1 "System performance monitoring" includes a) regular production of verification and diagnostics from operational systems , b) coordinated model feedback to the consortium from NWP users , c) feedback of special relevance to the consortium coming from local teams.
MQA3.2, MQA3.3 and MQA3.4 consider diagnosis of and possible actions to alleviate model weaknesses regarding , respectively, processes in the free atmosphere, at the surface and as a consequence of data-assimilation. As a consequence this implies possible suggestions for modified or new code to be included in next common model cycle(s).
MQA3.5 serves as a coordinating task since it is proposed that representatives from MQA3 tasks meet at least twice a year to coordinate work and discuss conclusions from the work. This will assist the process of creating updates to the RWP during the coming year.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
MQA3.1	**"System performance monitoring"** **a)** Maintain routine production of verification and diagnostics from operational systems e.g. using tools developed in MQA1 and MQA2. Relevant diagnostics on obs-monitoring is included. Report any relevant abnormal behavior or availability of forecast and observations. Results from ensembles should be an essential part of this , including comparisons with other model systems , e.g. results from ECMWF. Operational times series of scores to be maintained when relevant. . **b)** feedback from coordinated user input, e.g. in the form of user Meetings and reports communicating model experiences from users, e.g. forecasters. **c)** feedback from local teams, e.g. special activities relevant for follow up by the consortium. This may include problem cases to be documented via specification of initial state plus boundary conditions and stored for common use, e.g. at ECMWF. Documentation why problem case is relevant for further studies by the whole consortium should be available.	Harmonie-Arome RCR staff: BeSa, EeSa, GeMo,XiYa, AhMe, IvAn,SuTo, FlMe,FlWe, ChWi , MaPe, HaDh, RaRo	Documentation from verification and diagnostics

MQA3.2	**“Diagnosis of model weaknesses (Atmosphere) “** **a)** Each CSC defines a number of tools to diagnose in detail the model quality and decide how the tools are used to assess model quality in relevant CSC setups of the model cycle to be tested. The tools are expected to involve use of 2-D and 3-D analysis fields, based on different observation sources , e.g. from satellites. Examples : 2-D fields of deducing humidity related fields (vertically integrated water, vertically integrated cloud condensate(s), radiance fields from e.g. SEVIRI to be compared with model counterpart. Also precipitation analyses over suitable areas , based on radar systems combined with in situ observations will be used when feasible. The diagnosis will include in-situ observations as much as possible (point observations from various sources , e.g. from radiosondes, flights. **b)** Diagnose properties and deficiencies of atmospheric processes of current model version and compare with proposed updates from dynamics and physics developments. Possibly propose code modifications to improve the next model cycle. .	Harmonie-Arome staff : SaTi, WiRo, KaIv, GeMo,BeSa,AhMe, IvAn,ChWi	Report on diagnosed issues - proposal for code modifications .
MQA3.3	**“Diagnosis of model weaknesses (Surface) “** **a)** Compare model profiles against profiles measured at European meteorological masts (MaKa) **b)** Verify surface solar- and infrared radiation against surface station networks measuring these fluxes (EmGl) **c)** Report results from operational use of MSG-SEVIRI data , e.g. as a verification tool (PiWa) **d)** Implement and test modified diagnostic formulas for the stable boundary layer (?)	Harmonie-Arome staff: MaKa,EmGl, PiWa	Report on diagnosed issues - proposal for code modifications
MQA3.4	“**Diagnosis of model weaknesses (data-assimilation)** “ Document impact of recent data-assimilation techniques (e.g. cloud initialization, field alignment and 4D-VAR) on model spinup. Possibly suggest or implement. Upgrades. For cloud initialization this includes initialization of fog.	Harmonie-Arome Staff: RoRa and data-assimilation team ?	Report on diagnosed issues - proposal for code modifications
MQA3.5	**“ Coordination and follow up “** Staff from the CSCs working of on MQA3 will communicate (meet) at least twice a year with the CSC leaders and possibly selected area leaders, e.g. in connection with the consortium All-Staff workshop and the EWGLAM meeting, in order to coordinate work and exchange experiences from MQA3.1 - MQA3.4. A summary of recommendations will be written by the end of the year to assist the planning of updates the coming year of the RWP.	Harmonie-Arome staff: SaTi, BeSa, RoRa, PaSa , ALADIN-LACE: MaDe (0.25)	Recommendations for updates to the RWP (report)
MQA3.6	AROME-France (and ARPEGE): the changes prepared for the operational models are evaluated in an e-suite, by a comparison of the scores during a verification period of at least two months, in order to assess their impact compared with the operational 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. Note that the e-suire verification encompasses both the global and LAM configurations of MF, as well as both deterministic and probabilistic systems (EPS).	MaJe, FaSt,JMVi, FrPo, YaPr, MF/GMAP	Documentation (report)

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
MQA3.1	BeSa, EeSa,GeMo,XiYa	Reports, e.g. on hirlam. org, (code updates if needed)	3 - 4 reports in 2021
MQA3.2	SaTi, WiRo, KaIv,GeMo,BeSa	GRIB files with results + verification + source code	December 2021
MQA3.3	MaKa, EmGl ,PiWa, SiTh	Verification , report(s) + source code, GRIB-files with results	December 2021
MQA3.4	RoRa and data-assimilation team	GRIB files with results, verification, code with updates	December 2021
MQA3.5	SaTi, BeSa, RoRa,PaSa	Report(s) documenting results of initiatives and new cycles	December 2021
MQA3.6	MaJe, FaSt,JMVi, FrPo,YaPr	E-suite report	December 2021

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	1
BeUl	Bert van Ulft	KNMI Netherlands	1
OlVi	Ole Vignes	MET Norway	1
NiSo	Niko Sokka	FMI Finland	1
PhMa, REK	Philippe Marguinaud, Ryad El Khatib	Météo-France	3
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) can provide the model with a speedup of hopefully a factor of about ~3-4, and has an interesting potential for reduction of energy consumption, at the cost of recoding (into Data Specific language - DSL - 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. Meteo-France keeps close contact with ECMWF to adapt IFS optimizations to the AAAH LAM code.

Descriptions of tasks

Task	Description	Participant abbrev.h	Type of deliverablei
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. The 4DVar code will be available by the end 2020 in cy43h2.2 and phased to cy46	DaSa	
SY1.5	Continue exploring single vs double vs mixed precision studies for cy46	OlVi	Non-t-code
SY1.6	Use of the outcomes from the HIRLAM founded project with Barcelona Supercomputer Center about the Harmonie performance analysis realized in 2020. - Use the Extrae and Paraver for more regular analysis and possible effects of new codes on the computational efficiency - Use off Dinemas for ideal machine simulations (no latency, infinite bandwidth) - Explore the possibility of the use of the RPE fortran library to emulate floating-point arithmetic using a specific number of significand bits to evalute the best use of SP, DP or MP codes. - Evaluate the different compilers efficiency in the ECMWF AMD machine	NiSo	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
SY1.9	Portability: Explore the use of Containers, use of Vitual Machines like MUSC initiative, other HW architectures like ARMs an other similar initiatives	DaSa	non-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	AEMET Spain	2
NiSo	Niko Sokka	FMI Finland	3
BeUl	Bert van Ulft	KNMI Netherlands	2
EoWh	Eoin Whelan	MET Eireann	1
OlVi	Ole Vignes	MET Norway	1
UlAn	Ulf Andrae	SMHI Sweden	0.5

WP objectives

The Harmonie Reference System consists of source code, scripts, utilities and documentation for deterministic and probabilistic forecasting. A robust Harmonie Reference System which is demonstrably suitable for operational use is the main deliverable of the Hirlam collaboration. In the Harmonie Regular Cycle of Reference (RCR), one or more member services undertakes the responsibility to adopt the latest full release of the Harmonie Reference System as their operational model. The role of the RCR is to ensure and demonstrate the technical and meteorological capability of the model in an operational environment. The responsibility to act as RCR center rotates among Hirlam services, in line with major new releases. Until 2016 the RCR commitment only involved the deterministic model, but as HarmonEPS is nowadays an integral part of the system it will be included in future RCR commitments as well.
The Reference System contains more than the Harmonie-Arome canonical model configuration code, which at present consists of the Fortran code of the forecast model. The efforts on maintenance of the 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		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.		Non-t-code
SY 2.3	Test injection of observation data at ECMWF and operational platforms running RCR		Non-t-code
SY 2.4	Ensure platform equivalence between the Reference system at ECMWF and operational RCR platforms on meteorological aspects		Non-t-code
SY 2.5	Continue the GRIB2 encoding in the remaning SURFEX outputs.		Non-t-code
SY 2.6	Introduce more dinamical suite management by ecFlow using python API. This task is related with SY3 WP about using JSON/TOML/YAML languages in Harmonie-Arome scripting system		Non-t-code
SY 2.7	Webbinars on GIT use and working practices. Stablish a GIT GUI.		Non-t-code
SY 2.8	Arrange virtual or presential training Harmonie and its components for newcomers in 2021.		Non-t-code
SY 2.9	Design and implement mitraillete and/or Davaii and/or ECMWF testing tool tests for Harmonie		Non-t-code
SY 2.10	Based on the multirepository strategy: build a prototype for gl as external tool available for the whole consortium. Include, among other features, the possibility of aerosol data treatment from CAMS as is described in PH6		Non-t-code
SY 2.11	Progress on more portable model versions using Virtual Machine like MUSC or cointainers		Non-t-code
SY 2.12	Implementation of Titan/GridPP primarly as part of HR setups and crowdsourced data and also for new surface physics. Evaluate them as a possible Canari replacement tool.		
SY 2.13	Perform the adaptations needed to a parallel coexistence of HARP and Monitor after evaluation HARP det verification capabilities in MQA2. The long term objetive will be to phase out Monitor		Non-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		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	Daniel Santos(2)	AEMET Spain	2
KaSa	Kai Sattler	DMI Denmark	1
PaMe	Paulo Medeiros	SMHI Sweden	1
NiSo	Niko Sokka	FMI Finland	1
AlDe	Alex Deckmyn	RMI Belgium	0.5
YuBa	Yurii Batrak	MET Norway	0.5

WP objectives

A flexible scripting system is a key tool, to not only to run operational NWP suite, but is easy to extend to a number of other different potential applications, like nowcasting, reanalysis, or climate modeling. Although, in SY4 we want to explore the possibility to converge to a common scripting system for all AHL consortia members, in the meantime there is a clear necessity of maintaining the operational suites and research activities in HIRLAM.
The Harmonie scripting is a complex system with a lot of legacy codes and a variety of scripting languages. The scripts have been modified to be able to run HIRLAM to Harmonie and from mSMS scheduler to EcFlow. Also, these legacy codes have some obsolete parts and are mixture old scripting languages that are not well known by many users. During the last years we performed some steps to rewrite the scripting in an incremental way. One of these initiatives have conducted to the PrepLAM approach, which opens the possibility to set up a system that can use machine readable ASCII configuration, like toml, yaml or json, and emulates the same environment as the scripts expect today and the same scheduler flow. The aim of this approach is to separate configuration and logics part of the scripts to facilitate transparency, interoperability and testability of the scripting system. We expect these characteristics would be needed in a future common scripting system as well. A next step will be to continue rewriting of the ecFlow setup and job submission strategy. The rest of the scripting system can be rewritten in smaller steps to be consistent with the system convergence actions in ALH described in SY4.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SY3.1	Possible impact of multi repo ideas in HIRLAM scripting organization and necessity of bundeling	PaMe,RoSt	Non t-code
SY3.2	Adapt the scripting to cmake compilation environment and multi repository str	RoSt, YuBa	Non t-code
SY3.3	Continue with the development of the new python submission strategy and ecFlow interaction	DaSa	Non t-code
SY3.4	Establish the most efficient separation between JSON/TOML/YAML configuration files and logics	RoSt	Non t-code
SY3.5	Continue the emulation of the former funtionalities of the Harmonie scripting cleaning the obsolete parts and using the configuration files as input	KaSa	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	2021
SY3.5	DaSa	Scripts	2021

ALADIN/HIRLAM/LACE WorkPackage description : SY4

WP number	Name of WP
SY4	NEW !!! Towards a more common working environment: explore practical choices, prototyping, scripting
WP main editor	**Daniel Santos-Munoz, Oldrich Spaniel, Claude Fischer, Alexandre Mary, Alex Deckmyn**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
AlMa, FlSu, COOPE/	Alexandre Mary, Florian Suzat, COOPE/D, Harold Petithomme, GCO team	Météo-France	10
NiSo	Niko Sokka	FMI Finland	0.25
DaSa	Daniel Santos	AEMET Spain	2
RoSt	Roel Stappers	MET Norway	2
UlAn	Ulf Andrae	SMHI Sweden	1
AlDe	Alex Deckmyn	RMI Belgium	0.5
OlSp	Olda Spaniel	SHMU Slovakia	0.5
MEYa	Metin Emre Yakut	MGM Turkey	2

WP objectives

This Work Package describes the specific concrete tasks for enabling the evolution of System working practices and tools. These tasks are complementary to the exploration tasks defined in COM2.2.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SY4.1	Create a prototype code repository setup (content and structure) and bundling tool along the concepts developed in COM2.2.1. -prototype a multiple repository organization for NWP core codes -define a bundling tool, assess the one used by ECMWF. The ecbundle and bundle.yml definition infrastructure appears to be quite mature and should be evaluated as overall solution. -explore repository solutions for supplementary and new tools (testing tools, scripting, etc.)	AlMa, COOPE/D, GCO, RoSt, DaSa, UlAn	
SY4.2	Development of the unit testing based on DAVAÏ: -define and add new components as is described in COM 2.2.2 -create an interface which allows users to execute the Davai tool on other platforms and implement tests of components for different CSCs. -further define and develop expert components (Note: “expert components” are the tools used for evaluating the result of a given DAVAÏ test) -further develop a user-friendly tool and interface for visualizing the results of unit testing (eg. “ciboulaï”) -arrange training of key integrators to use the Davai tool, to allow them to locally test possible code contributions on a more regular basis.	AlMa, FlSu, HaPe, RoSt, NiSo, MEYa, OlSp	
SY4.3	Create a prototype platform for exchange of technical information which is well integrated with the multiple GIT repository infrastructure.	AlMa, FlSu, COOPE/D, GCO, RoSt, DaSa	
SY4.4	Scripting system: -assess the use of VORTEX for scripting. Work on modernization and split out of scripting aspects from NWP core code aspects for Harmonie is described in SY3.	RoSt, DaSa, NiSo, UlAn, MEYa, AlDe	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ALADIN/HIRLAM/LACE WorkPackage description : HR1

WP number	Name of WP
HR1	(Sub)-km modelling
WP main editor	**Sander Tijm, Martina Tudor, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
JaCa, DMP, DaSa, DaSu	Javier Calvo (1), Daniel Martin Perez (0.5), Daniel Santos (?), David Suarez (3)	AEMET Spain	4.5
JuCe	Jure Cedilnik	ARSO Slovenia	1
PeSm	Petra Smolíková	CHMI Czech	2
AnSi	André Simon	SHMU Slovakia	4
MaHr, IvDo	Mario Hrastinski, Iva Dominović	DHMZ Croatia	4
XiYa	Xiaohua Yang	DMI Denmark	1
IvAn, AhMe, SuTö	Ivar Ansper (4), Ahto Mets (1), Sulev Tõkke (1)	ESTEA Estonia	6
PiSe, MaSz, MaKo	Piotr Sekula, Malgorzata Szcech, Marcin Kolonko,	IMGW Poland	5
NaTh, SaTi	Nathalie Theeuwes (3), Sander Tijm	KNMI Netherlands	3
MaNa	Marass Najla	Maroc Meteo	
CoCl, JaFa	Colm Clancy (1), James Fannon (3)	MET Eireann	4
EMSa, YuBa, HaMl	Eirik Mikal Samuelsen (2)	Met Norway	2
RaHo, SaAn, YaSe	Rachel Honnert, Salomé Antoine, Yann Seity : CNRM/GMAP	Météo-France	17
DiRi, BeVi, MaMa, OlCa	Didier Ricard, Benoît Vié, Marc Mandement, Olivier Caumont : CNRM/GMME	Météo-France	16
KIIv	Karl-Ivar Ivarsson (0.25)	SMHI Sweden	0.25

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 took place in the winter 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.

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	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, BoBo, CoCl, XiYa, DaSu, JaCa, DMP, EMSa, NaTh, IvAn, AhMe, SuTö, AnSi,PiSe, MaSz, MaKo	report
HR1.2	Numerical methods on the km- and hectometric scale: study the limitations of the spectral approach and, possibly, the semi-Lagrangian scheme. Test limitations of the semi-implicit time-stepping for use at hectometric resolutions.	CoCl	report
HR1.3	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
HR1.4	Establish a model setup that would run dynamical adaptation of wind using the latest export version and establish optimal tuning of dynamics and TOUCANS.	MaHr, IvDo, AnSi	report, scripts, namelists, t-code ?

HR1.5	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, JaFa	configuration
HR1.7	Use of NetAtmo observations for very high resolution model validation. (1) evaluation of the NetAtmo data added value, (2) compare AROME & Méso-NH test cases against these data. This is part of the PhD work of Marc Mandement, under Olivier's supervision	MaMa, OlCa	report, non-t-code
HR1.8	Evaluation of AROME-500m over the Alps and for gust forecasting (in the framework of the TEAMX project), evaluate a reduction of the mass-flux effect following the work by D. Lancz and test on a EUREC4A case (in the framework of the Grey-zone project 2)	RaHo, DiRi, YaSe	report, non-t-code
HR1.9	Evaluate the behaviour of AROME on fog cases: case of underestimation and cases of false alarms. Use microphysics observations from the SOFOG3D campaign and LES simulation done at GMME. The AROME model configurations for Salomé's PhD work are the Arome-1.3km operational version and a purpose-tailored Arome-500m with 156 vertical levels.	SaAn, YaSe, RaHo, DiRi, BeVi	report, non-t-code
HR1.10	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, MaHr	report, non-t-code
HR1.11	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, PeSm	report, non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
HR1.1	XY, EO	report	
HR1.1	tbd	report	
HR1.2	CoCl, JS	report	
HR1.3	YaSe	namelists	
HR1.4	MaTu	report, namelist, scripts	
HR1.5		configuration	
HR1.6	tbd	report	
HR1.7	OlCa	report, non-t-code	
HR1.8	RaHo	report, non-t-code	
HR1.9	YaSe	report, non-t-code	
HR1.10	MaHr, PeSm	report, non-t-code	
HR1.11	MaHr (1), PeSm	report, non-t-code	