ACCORD

A Consortium for COnvection-scale modelling Research and Development

ACCORD
Rolling Work Plan 2022

Contents

Introduction

The writing of this document takes place in 2021, which is the first year of activity of the ACCORD consortium under the current first Memorandum of Understanding (MoU1 valid for 2021-2025). It might be appropriate to briefly recall the major steps of setting up the consortium. The main decisions for making the new governance and management effective were taken at the Assembly meeting of 27 November 2020, including the nomination of the Programme Manager and the 3 CSC-Leaders. In the follow-on Assembly (8 March 2021), the full Management Group (MG) staffing was adopted and the scientific management of ACCORD became active in this very same month (March 2021). The drafting of the early versions of the Rolling Work Plan (RWP) under the responsibility of the new MG started soon after the first ACCORD All Staff Workshop, in April 2021. In parallel, the MG and the Local Team Managers (LTM) elaborated the status of progress of the ongoing RWP-2021 that had been elaborated by the previous ALADIN-HIRLAM joint HMG-CSSI group, under the responsibility of the ALADIN and HIRLAM PMs. Though the arrival of the ACCORD consortium represents a significant achievement for a joint scientific management encompassing the NWP R&D activity of the 26 Member NMSs, the concrete structure and content of the scientific and technical activity has not been completely overhauled, in line with the considerations and advises formed during the convergence process of the previous years.

Nevertheless, the reader will notice a few adaptations and novelties in this document, presenting the ACCORD rolling work plan (RWP) for 2022.

The main aim of the RWP is to provide clarity on the expected evolution of the common codes in the coming 1-2 years, on the objectives underlying the scientific developments and on the resources invested in those developments 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, and on the general support for local implementations, troubleshooting, training and information exchange (Section 1).
- A limited number of strategic (core) programs: commonly agreed programs of recognized strategic importance that will benefit all partners (Section 2). At this stage, there is one single strategic program, on transversal software developments (SPTR1), which has started in 2021. 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 parametrizations, surface analysis and modeling, ensemble forecasting, very high resolution modeling, machine learning, meteorological quality assurance and technical code and system development. In the detailed work package descriptions, which are given in Section 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 Annexes 1 (timing of IFS/ARPEGE/LAM cycles) and 2 (content of recent and upcoming cycles). The full list of Work Packages (WP) defined in the RWP is given in Annex 3.

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

Work package MNGT4 contains the planned work of the new ACCORD Programme Manager (PM), the Consortium Scientific Secretary (CSS), the three CSC Leaders (CSC-L) and the coordination work done by the Local Team Managers (LTMs).

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 ACCORD common codes during code integration, to validate and maintain them in a scientific and technical sense, to ensure its technical 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's working practices (which are described in work package COM2.1).

Furthermore, the activities required for achieving the strategic longer-term goal of creating an improved process for code evolution are described in work package COM2.T.

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 latest cycles of the ACCORD 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 EWGLAM/C-SRNWP meetings

1.2 The expected evolution of the common codes

1.2.1 T-cycles construction and porting to Members

The R&D developments described in Sections 2 & 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 on the next few cycles is presented in the Annexes 1 & 2. Below, the major aspects of code management are described.

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 ACCORD joint code versions that are constructed in the same trunk as the IFS/ARPEGE code versions. Therefore, their timing is guided strongly by the decisions of the IFS/ARPEGE collaboration which settles the content and timing of the NWP codes shared between Météo-France and ECMWF (Note: the ACCORD representatives are observers in these meetings). In practice, a new IFS/ARPEGE joint cycle is decided about every year 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 2021.

T-cycles receive LAM (limited area model) R&D contributions and can be technically evaluated mostly by sanity checks by the so-called "davaï" and "mitraillette" tools. Building a T-cycle requires about three to four months of gathering contributions, followed by two to three months of finalization of merging and technical validation. Subsequently, validation will be done of all components for each CSC (including e.g. CSC-specific tools, scripts, and perturbation methods) separately.

From CY48 onward, "davaï" will increasingly be used for the assessment of contributions, initially together with mitraillette; but eventually "davaï" is expected to replace the mitraillette tool. Davai can presently be used within the Meteo-France infrastructure and it is expected that a version of davaï will be fully ported and available in the ECMWF HPC environment by the end of 2021 or beginnning of 2022. It is also aimed to later port the tool more widely to other platforms, in order 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 ACCORD 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 in the first years of ACCORD. Another aspect that will be considered is the transition from technical to meteorological quality assurance, which are two complementary aspects and 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, and 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 modeling 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 the documentation, Newsletters and at regular Consortium workshops.

1.2.2 Additional information

Integration of 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 code integration efforts that are regularly being organized by Météo-France (at least once per year). During this code integration work, the last code release of the IFS (so-called R-cycle) is merged 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 code integration work is organized by 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 ACCORD (former ALADIN) Members are invited to Météo-France and provide about 1 FTE of additional manpower for this sometimes tedious code phasing[1]. 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 ACCORD lead scientists and System Experts.

In addition to the main NWP shared codes of the IFS-ARPEGE-LAM "ecosystem", 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 within the evolution of the working environment. In a few words, the idea is that, in order to run NWP applications, not only do we need a certain version of the IFS-ARPEGE-LAM (IAL) shared codes, but also a "bundle" of compatible versions of additional projects, such as OOPS, SURFEX, etc…

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 tasks defined for designing and exploring new working practices for code integration are described in WP COM2.T.

1 In 2020 and 2021, the COVID situation forbid any such physical visit to Toulouse

2. Strategic (core) programs

2.1 Strategic program on Transversal software developments

In the ACCORD strategy 2021-2025, it was decided to introduce a new strategic program on Transversal software developments, SPTR1. The SPTR1 program aims to prepare our codes to function efficiently and in a maintainable manner on the computational hardware of the future. The key element to achieve this is to follow the approach of separation of concerns, in close cooperation with ECMWF's Scalability program. The challenge is therefore to develop new layers of software that are capable of generating efficient hardware-specific codes, starting from high-level abstract scientific codes. For this purpose, the intention is to study and use the domain-specific language (DSL) approach that was adopted by ECMWF.

Atlas is a framework 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 ACCORD 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 ACCORD 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.

The concrete example of porting the common codes to hybrid CPU-GPU platforms has triggered additional considerations, such as study the possibility to use physics parametrizations in a parallel mode, so that several processes could be called (ie computed within one time step call) on separate processing units (with a target on GPU, at least for some of these parametrizations). Such study requires both a technical (programming) analysis and a scientific one, since some processes originally have some sequential ordering for physical relevance or numerical stability reasons. Prototyping part of the model code, especially at the level of the physics, is being considered in order to study various possible solutions. The prototyping then also includes some temporary simplification of complex code. These studies could be further triggered (hopefully accelerated) by the goals and means of the DestinE Project, should ACCORD Members become involved in this Project.

Ongoing activities to optimize the code on existing familiar HPC platforms, are addressed in the SY1 work package.

3. Prospective R&D activities

3.1 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, such as 4D-Var and 3/4DEnVar (WP DA2).

Increasingly, the ACCORD LAM models are also 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 correction; 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. 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 in a stepwise manner a basic data assimilation system for all members who do not yet possess it or who are in an early phase of daily testing.

In 2021-2022, much of the activity in the DA Area will be organized by research or system teams, who each have a specific set of tasks under the supervision of the DA Area Leader (and a few associated co-leaders as well as the MG). A set of generic Terms of Reference have been drafted by the DA AL and the PM in order to describe the overall scope and ambition of these teams. The teams' activity reflects the content of the WP in the RWP-2022.

The inventory and the evaluation of possible data assimilation solutions for seamless (nowcasting to NWP) time ranges, and with a view on very high resolution (hyper-resolution) applications, will be the task of a dedicated WG suggested by the ACCORD MG. This WG activity will be in link with WP DA5 as well as DA1-2-3-4 mostly.

3.2 Dynamics

The present dynamical core of all three CSC's is based on spectral transforms, 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 equations.

3.3 Atmospheric physics parametrizations

The key difference between the three present CSCs AROME-France, HARMONIE-AROME and ALARO, lies in their choices for the physics parametrizations. Hence, the work packages in this area have partly been organized along the lines of CSC's: WP PH1 describing the research on AROME-France physics, WP PH2 on HARMONIE-AROME, and WP PH3 on ALARO. It is aimed to make these three main physics configurations more interoperable, at the level that individual parametrizations can be exchanged in the future across CSC's. It is the goal of the WG on Physics Interoperability, decided at the ACCORD Assembly level, to prepare a roadmap by end-2022 for achieving this level of interoperability, and start up the related activities when agreed. The activity of the WG, along with the progress and plans on interoperability of the physics, are described in WP PH9.

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 (at the level of fullpos) that is relevant to add to the common code for all CSCs, and make plans and preparations for developing, implementing and sharing such new post-processing. WP PH6 is devoted to the creation of a more realistic and consistent description of aerosols, and of the cloud-radiation-aerosol-microphysics interactions, within the different physics parametrizations. In WP PH7, new approaches will be developed for (quasi-) 3D physics, required for modeling at very high spatial resolutions. In WP PH10, the options will be studied for developing more truly stochastic formulations for the physics parametrizations.

3.4 Surface analysis and modeling

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 permit 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

In previous years, the work packages in this area were mostly organized along the lines of the three CSC's on which the existing convection-permitting ensemble systems within ACCORD (the AROME-France PEARO, HarmonEPS, and the LACE ALARO-based ensemble systems) are based. This year, they have been reorganized instead along the lines of the types of perturbations which are being used in the existing convection-permitting ensemble systems:

- Model perturbations (WP E9).
- Initial condition perturbations (WP E10)
- Surface perturbations (WP E11)
- Lateral boundary condition perturbations (WP E12)

In addition, work will be done on:

- Ensemble calibration and post-processing techniques (WP E6), using novel ML and DL approaches
- Development of more user-oriented approaches to ensemble output and post-processing (WP E7)
- the preparation, evaluation and migration of the convection-permitting ensembles (WP E8), both for CSC-based applications in home institutes and for joint applications run at ECMWF

3.6 Meteorological 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 for verification and quality control (WP MQA2), define new metrics, assess a wider use of satellite-based or ground-based high resolution observations, enhance the possibilities of neighborhood methods etc.
- 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)
- the maintenance and development of the HARMONIE Reference System (restricted to those activities not aimed at the development, validation and introduction of HARMONIE code into the common ACCORD system (which is described in WP COM2.1)) (WP SY2)
- the revision of the HARMONIE scripting system (WP SY3)
- the development and implementation of a more common script system (SY4). Other elements of a common ACCORD working environment (such as a multi-repository setup, a common testing environment based on Davaï, and a common platform for technical information exchange which is well integrated with the multiple GIT repository infrastructure) will be designed and created in WP COM2.T.

3.8 Towards high-resolution modeling

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.

The ACCORD MG has proposed to build a specific WG in order to elaborate a work plan for very high resolution (hyper-resolution) modeling, encompassing the definition of relevant model configurations, validation, predictability assessments and appropriate data sets (its activity is referenced in WP HR1).

3.9 The application of machine learning in the ACCORD LAM models

The aim in this area is to achieve an increased application of machine learning (ML) techniques in the various parts of the LAM analysis and forecast model systems. These applications will focus on using ML both for obtaining observations and model results of higher meteorological quality, and for emulating the existing NWP methodologies with ML at lesser computational cost or enhanced scalability. These activities (WP ML1) are truly transversal in the sense that they require expertise across the full width of NWP model development.

For 2022, it was decided to group existing ML activity within ACCORD in one single WP (ML1). This choice materializes the transversal aspect of ML. However, in the (expected) case that ML R&D becomes more and more active in the consortium, casting these activities throughout the thematic NWP Areas will be considered.

The ACCORD MG has proposed to set up a dedicated WG with the aim to elaborate a portfolio of core NWP problems where Machine Learning could be potentially applied (WG-ML whose activity is referenced in WP ML1). The composition of the WG includes volunteering staff from the various blood families of the consortium, along with a few persons who already have been addressing the use of ML (generally, on the side of post-processing or applications which have been on intention left outside of the scope of the WG-ML).

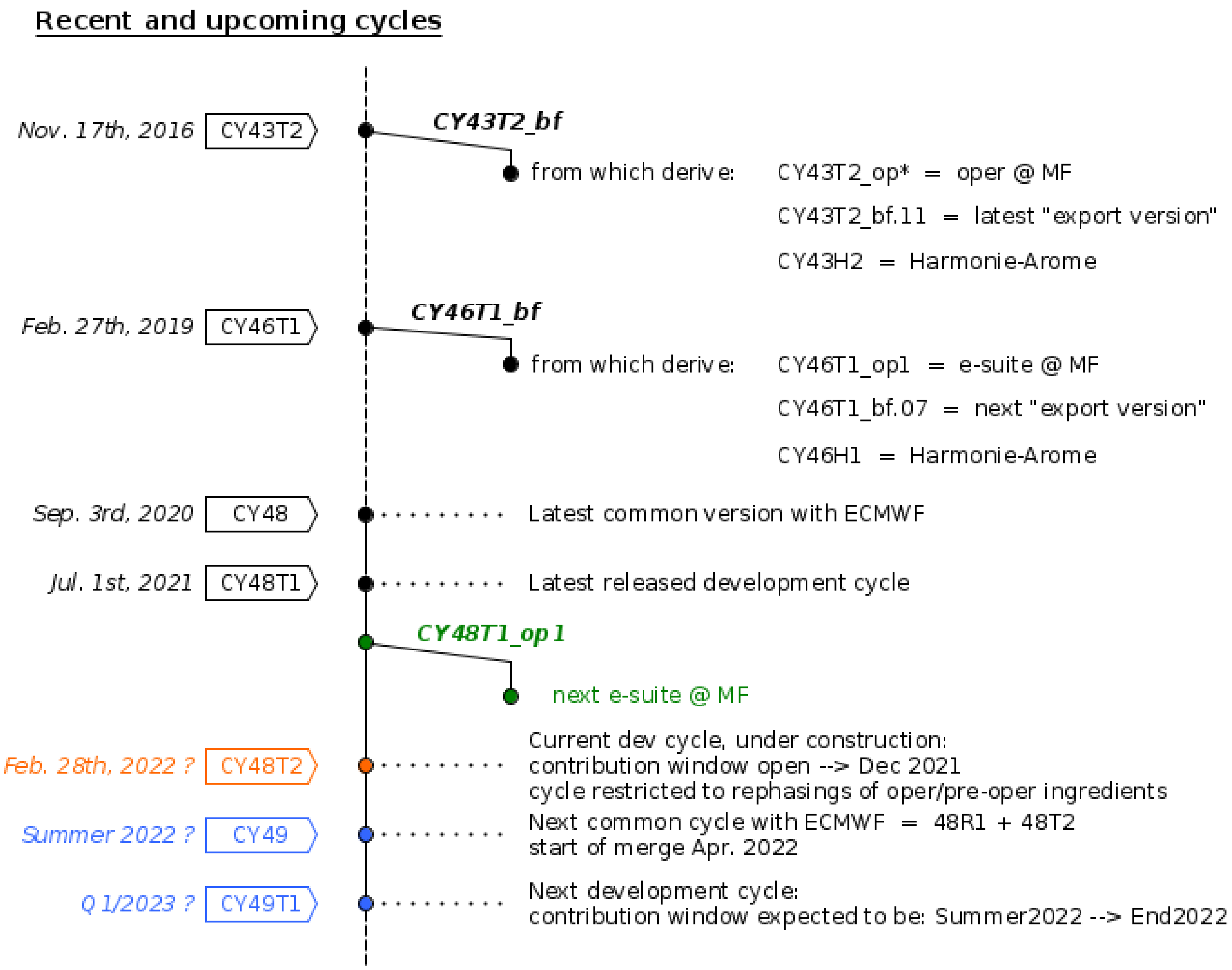
Annex 1: Timeline of common cycles

Hereafter is a draft table of timing of recent and upcoming IFS/ARPEGE/LAM cycles.

Joint cycle	ECMWF	MF	Start of phasing	Declaration	Misc. / Oper plans
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	Single precision runs in ENS ***Note: this code not included in CY48 !***
	CY47R3		?	?	***Note: this code not included in CY48 !***
CY48			6-10 Jan 2020	3 Sept 2020	
		CY48T1	Oct 2020	7 July 2021	Could be a base version for OOPS/3DEnVar in AROME-France ?
		CY48T2	Summer 2021	Q1/2022	Rephasing of oper/pre-oper developments throughout ACCORD on top of 48T1 + OOPS developments for full OOPS assimilation configurations.
	CY48R1		Q1/2022	Q2/2022	CY48+CY47R3 rephasing + some scientific developments
CY49			Spring 2022 ?		CY48R1+CY48T2
		CY49T1	Summer 2022	Q1/2023 ?	Tbc in 2022
	CY49R1		Late 2022	2023	OOPS operational for 4D-VAR/IFS (tbc)

Annex 2: Common cycles and preliminary content

(status of this list as of 1 September 2021)



CY46T1_bf:
Validation of ARPEGE and AROME applications (ARPEGE 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 ARPEGE/AROME versions (from CY43T2):

- **CY46T1_bf.04**: match up with CY43T2_op4 and base version for a long run validation of ARPEGE 4D-VAR (2 month validation period in GMAP started with this version) [9 June 2020]
- **CY46T1_bf.05**: 2 month-long ARPEGE 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.07**: gathering of fixes provided by GMAP, LACE and HIRLAM system coordination people

CY46T1_bf will become an export version.

CY48: January – August 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 (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 has been led 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.
   Because of a delayed planning of CY49 (shifted to 2022) and a few contributions more difficult to validate and merge, the finalization step lasted until spring 2021, and declaration occurred on July 7th 2021. Detailed contents to be found in
   https://opensource.umr-cnrm.fr/attachments/download/4074/Contents_48T1.pdf

CY48T2: this cycle was originally not planned but the opportunity to make it was provided by the shifted schedule of CY48R1 by ECMWF expected for March/April 2022. However, since by the time of starting the merge of CY49, two years will have ran since the merge of CY48, and in order to ease this process, we wanted to restrain the contributions to CY48T2 to the "least likely to be postponed". Hence, the expected content of this cycle is only developments that have already an operational or pre-operational status in local branches of common cycles, eg. 46T1_op1 or 46H1. In addition to that, some OOPS developments that enable full assimilation configurations, able to reproduce operational ARPEGE and AROME assimilation configurations, will be accepted. These developments will open from CY48T2 onward the possibility for extending the OOPS-based assimilation solutions to other configuration, LAM 4D-Var or more specific algorithms.

CY49: common cycle with ECMWF consisting in the merge of CY48T2 + CY48R1.
The merge of this cycle is expected to take place as soon as its 2 parent cycles are available, which is probably beginning of April 2022.
It is planned to introduce some structural changes in the way ECMWF and MF exchange the codes for this exercise. A main change will be to make a joint GIT history from the two MF and ECMWF GIT repositories, in order to get a common branch that will enable more frequent and easy exchanges of phasing and corrections in the build of common cycles.

CY49T1: Contents to be discussed in 2022

Annex 3: Work packages and staff resources for 2022 (person/month)

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<tr><td>DA8</td><td>Basic data assimilation setup</td><td>55.75</td></tr>
<tr><td>Physics</td><td>PH1</td><td>Developments of AROME-France (and ARPEGE) physics</td><td>49.5</td></tr>
</table>

Parametrizations	PH2	Developments of HARMONIE-AROME physics	*31.75*
	PH3	Developments of ALARO physics	*45*
	PH4	Common 1D MUSC framework for parametrization validation	*9.75*
	PH5	Model Output Postprocessing Parameters	*31.75*
	PH6	Study the cloud/aerosol/radiation (CAR) interactions	*18.25*
	PH7	Develop approaches for 3D physics	*13.75*
	PH9	Consistency and convergence of the CSC physics	*13*
	PH10	Fully stochastic physics parametrizations	*6*
Surface analysis and modelling	SU1	Algorithms for surface assimilation	*25.25*
	SU2	Use of observations in surface assimilation	*17*
	SU3	SURFEX: validation of existing options for NWP	*32.75*
	SU4	SURFEX: development of model components	*13.5*
	SU5	Assess/improve quality of surface characterization	*28*
	SU6	Coupling with sea surface/ocean	*32.5*
Ensemble forecasting and predictability	E6	Ensemble calibration by use of machine learning and deep learning algorithms	*43*
	E7	Develop user-oriented approaches	*79.75*
	E8	EPS preparation, evolution and migration	*43*
	E9	Model perturbations	*59.5*
	E10	Initial condition perturbations	*7*
	E11	Surface perturbations	*16*
	E12	Lateral boundary perturbations	*11*
Meteorological quality assurance and verification	MQA1	Development of HARP	*22*
	MQA2	Development of new verification methods	*28.5*
	MQA3	Meteorological quality assessment of new cycles and alleviation of model weaknesses	*130.75*
Technical code and system development	SY1	Code optimization	*12.75*
	SY2	Maintenance and development of the Harmonie Reference System	*15*
	SY3	Revision of the Harmonie scripting system	*5.25*
	SY4	Towards a more common working environment: explore practical choices, prototyping, scripting	*7.75*

ACCORD WorkPackage description : MNGT4

WP number	Name of WP
MNGT4	ACCORD Management
WP main editor	**Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PM	Programme Manager	Météo-France	11
CSS	Consortium Scientific Secretary	Météo-France	11
IL	Integration Leader => accounted for in COM2.1, COM2.T and SY4	Météo-France	
AL	Area Leader (8 Areas) => not accounted for in MNGT4. Each AL reports his/her work in the appropriate WPs of the Area. No manpower accounted in MNGT4.	(not relevant)	
CSC-L	Canonical System Configuration (CSC) Leader: AROME	Météo-France	5.25
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
FrBo, GhFa, ErEs	François Bouyssel (1), Gislain Faure (0.5), Eric Escalière (3)	Météo-France	4.5
LTMs	Local Team Manager	ONM Algeria	1
LTMs	Local Team Manager	ZAMG Austria	1
LTMs	Local Team Manager	RMI Belgium	1
LTMs	Local Team Manager	NIMH Bulgaria	1
LTMs	Local Team Manager	DHMZ Croatia	1
LTMs	Local Team Manager	CHMI Czech	1
LTMs	Local Team Manager	OMSZ Hungary	1
LTMs	Local Team Manager	Météo-France	1
LTMs	Local Team Manager	Maroc Meteo	1
LTMs	Local Team Manager	IMGW Poland	1
LTMs	Local Team Manager	IPMA Portugal	1
LTMs	Local Team Manager	Meteo Romania	1
LTMs	Local Team Manager	SHMU Slovakia	1
LTMs	Local Team Manager	ARSO Slovenia	1
LTMs	Local Team Manager	INM Tunisia	1
LTMs	Local Team Manager	MGM Turkey	1
LTMs	Local Team Manager	DMI Denmark	1
LTMs	Local Team Manager	ESTEA Estonia	1
LTMs	Local Team Manager	FMI Finland	1
LTMs	Local Team Manager	IMO Iceland	1
LTMs	Local Team Manager	MET Eireann	1
LTMs	Local Team Manager	LHMS Lithuania	1
LTMs	Local Team Manager	KNMI Netherlands	1
LTMs	Local Team Manager	MET Norway	1
LTMs	Local Team Manager	AEMET Spain	1
LTMs	Local Team Manager	SMHI Sweden	1

WP objectives

This WP sheet describes the tasks and manpower requested for the Management of the ACCORD 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	preparatory documents, minutes & recommendations
MGMT4.3	Elaboration and execution of the RWP, reporting to the GA	PM, CSS	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	**FrBo**, **GhFa**	
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

ACCORD WorkPackage description : COM2.1

WP number	Name of WP
COM2.1	Code generation and maintenance: regular maintenance and evolutions, official releases
WP main editor	**Alexandre Mary, Daniel Santos**

Table of participants

(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)

Participant Abbreviation	Participant	Institute	PersonMonth
GCO, COOPE/D, AlMa, HaPe, REK, YvBo, InEt, OlJa, CeLo, AdNa, JMP, YaSe, PaSa, FlSu, FrGu, MaMa, MaMo, MFSci	GCO team (2.25), COOPE/D (3), H. Petithomme (2.5), R. El Khatib (3), Yves Bouteloup (1), Ingrid Etchevers (1.5), Olivier Jaron (1.5), Cécile Loo (1.5), Adrien Napoly (1.5), Jean-Marcel Piriou (1.5), Yann Seity (1.5), Patrick Moll (6), P. Saez (5), Frank Guillaume (3), Matilde Moureaux (9), Maud Martet (1), Christoph Payan (4), Benoit Vié (2), Météo-France scientific code experts as requested (we assume the corresponding figure of manpower is committed directly in the relevant WPs)	Météo-France	47.5
IL	Integration Leader - AlMa (4.5)	Météo-France	4.5
SysAL	System Area Leader - DaSa	DMI Denmark	1
CNA	Coordinator for Network Activities - MaDe	SHMU Slovakia	1
DaDe	Daan Degrauwe	RMI Belgium	
ASCS	Oldrich Spaniel - LACE ASC	SHMU Slovakia	4
PHAS	phasers in Toulouse (Note: the total amount of non-MF 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	2
PHAS	Algerian team	ONM Algeria	2
ToMo, WidR, JaBa	Toon Moene (1), Wim de Rooij (1), Jan Barkmeijer (0.5)	KNMI Netherlands	2,5
EoWh	Eoin Whelan	MET Eireann	
CSC-Leaders	Eric Bazile	Météo-France	0.5
CSC-Leaders	Martina Tudor	DHMZ Croatia	0.25
CSC-Leaders	Jeanette Onvlee	KNMI Netherlands	0.25
ClFi	Claude Fischer (part of my PM reporting)	Météo-France	

WP objectives

This WP lists the major tasks necessary for preparing, building and validating new versions of the code for all of the 3 CSCs.
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. The WP describes tasks within the environment issued from the transition WP COM2.T

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
COM 2.1.1	Cross-coordination aspects for planning timing and content of T-cycles (exchange of information, tele-meetings, preparatory documents). This cross-coordination involves efforts at various levels: 1. the core T-cycle coordination (central role of IL, with SysAL and other MG members, CNA), 2. link with the IFS/ARPEGE coordination, 3. link and efforts done inside the Hirlam System Group (for H-cycles)	COOPE/D, IL, CNA, SysAL, ClFi	docs
COM 2.1.2	Build of new IFS/ARPEGE/LAM common releases, as defined by the ECMWF/Météo-France coordination meetings. Note that LAM tests are being evaluated in these joint cycles, i.e. the LAM CSCs should ideally work with these releases.	GCO, COOPE/D, IL, HaPe, REK, PaSa, FrGu, MaMa, PaMo, ChPa, MFSci, PHAS, ASCS	t-code (complete)
COM 2.1.3	Build of a T-cycle ARPEGE/LAM version, common to ACCORD. These are the cycles that will contain scientific and technical changes from the LAM groups (and from MF for ARPEGE). - Forward phasing of local branches (e-suites // H cycles, MF_op branches) to the latest common cycle - Preparation of development branches - Reviews of other contributors branches, for the sake of technical quality, in the process of continuous integration.	IL, COOPE/D, pool of integrators, MFSci, ASCS, SysAL, YvBo, InEt, OlJa, CeLo, AdNa, MaMa, JMP, YaSe, PaMo, ChPa	t-code (complete)
COM 2.1.4	Technical validation: - Maintenance of test system (Davaï), adapting test bench to CSCs evolutions, and introducing new tests (based on requests from CSCs ?), new functionalities - Coordination and reporting on Special Project SPFRACCO for computing resources dedicated to technical validation (testing) of contributions to a T cycle.	IL, SysAL	Scripts, input resources (namelists, initial conditions, etc...) & SP report

COM 2.1.5	Generation of CSCs after building and validation of a T cycle. - Meteorological validation in near-real context. - Forward phasing of local add-ons to latest T cycle - Adapting Davaï tests to CSCs evolutions (2.1.4)	SysAL, CSC leaders, IL	
COM 2.1.6	Coordination between ACCORD teams about CSCs content and latest operational needs	CSC leaders, IL, ...	
COM 2.1.7	Reporting, tracking, phasing among branches/releases of bugs and bugfixes	IL, SysAL, COOPE/D, CNA	t-code & tickets
COM 2.1.8	Preparation and chairmanship of the Local Teams Representatives for System meetings. Coordination on working practices in general, and on best practices for integration (as local support for the R&D staff).	SysAL	
COM 2.1.9	Think about documentation of the code: what, where, how... ?	DaSa, ClFi, AlMa	

t-code deliverables

Task	Responsible	Cycle	Time
COM 2.1.2	COOPE/D, IL	CY49	Beginning of phasing in April 2022, expected declaration in summer 2022
COM 2.1.3	IL	CY48T2	Contribution deadline end of Dec. 2021, Declaration in March 2022
COM 2.1.3	IL	CY49T1 ?	timing to be discussed, end of 2022 to beg. 2023 ?

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM 2.1.1	COOPE/D, IL, SysAL, CNA, ClFi	documentation, communication	2/year @LTM meeting & @IFS-Arpège coordination meetings
COM 2.1.4	IL, SysAL	Updates of testing system Davaï (scripts, data)	regular, as needed
COM 2.1.7	IL, SysAL	bugfixes, tickets	regular, as needed

ACCORD WorkPackage description : COM2.T

WP number	Name of WP
COM2.T (Transition)	Code generation and maintenance: Transition to new work practices and environment
WP main editor	**Alexandre Mary, Daniel Santos**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
AlMA, FlSu, COOPE/D, HaPe, PaSa, GCO	Florian Suzat (1.5), Ghislain Faure (COOPE/D) (0.5), Harold Petithomme (1.5), Patrick Saez (0.5), GCO team (0.5)	Météo-France	4.5
RoSt	Roel Stappers (part of Hirlam Code Analyst position)	Met Norway	0.5
ClFi	Claude Fischer (part of PM activity reporting)	Météo-France	
IL	Integration Leader - Alexandre Mary (4.5)	Météo-France	4.5
SysAL	System Areal Leader - Daniel Santos	DMI Denmark	3
CSC-Leaders	Eric Bazile	Météo-France	0.25
CSC-Leaders	Jeanette Onvlee	KNMI Netherlands	0.25
CSC-Leaders	Martina Tudor	DHMZ Croatia	0.25

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, and in other "satellite" tools. 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 ACCORD 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. The objectives of this work package is to set up new methodologies, work practices and environment for this purpose. It is a temporary work package, in that it describes the tasks to complete in order to achieve this transition.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
COM2.T.1	**Set up a shared multiple repository infrastructure (a.k.a. "forge")** named after ACCORD, and associated working practices (pull requests, ticketing, reviewing, ...). Ensure access to the repositories by the main ACCORD developers sharing the responsibility for the maintenance of the three CSC's.	IL, COOPE/D, GCO, ClFi, SysAL	Accessible Forge
COM2.T.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 accessibility of the tests and testing tools by the main ACCORD developers. - 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. - Continue the transfer of selected tests from Mitraillette to Davaï, with the aim of the latter to takeover in the end	IL, FlSu, PaSa, HaPe, SysAL, RoSt	Scripts, packages, input resources (files, namelists, etc.) + doc
COM2.T.3	**Define a bundled environment for the shared codes.** Define how to reorganize codes in separate repositories (NWP, OOPS, Surfex, ...) and gather them using the bundling tool from ECMWF (ecbundle). Adapt procedures (contribution, davaï, building versions, compilation).	IL, SysAL	Documentation + adaptation of tools
COM2.T.4	**Monitor 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.	IL, SysAL, COOPE/D, ClFi	Documentation
COM2.T.5	**Plan training about these new tools/practices** 2.T.1 (git/git forge), 2.T.2 (Davaï), 2.T.3 (bundling)	AlMa, COOPE/D, ClFi, SysAL	Trainings sessions + supports

COM2.T.6	**Explore solutions and set up a common platform for exchange of information.** The goal is to have an ACCORD common platform where to host semi-permanent documentation, meeting notes and other material (eg web-links) that are relevant for scientific management. The assumed choice would be to go for some Wiki solution with an easy access and simple (yet secure) user/account management system.	ClFi, AlMa, DaSa, PaPo	Accessible WIKI solution
COM2.T.7	**Explore a more common methodology to CSCs generation, increase the components testability and interoperability.** This task includes steps of brainstorming by integration and system experts, and steps of design and development. Specific questions are formulated for starting this exploration in 2021-2022: - be able to define the CSCs based on common T-cycle versions - progressively add some components of a common scripting to the CSC definitions (link with SY4) - each CSC should define its NWP individual components for testing. It is expected that components of DA and EPS would be rather simple at the start, with the intention to progressively extend the CSC definitions (eg test chaining of components, test cycling, test an ensemble of several members). Each CSC team might decide on the level of complexity that it wishes to promote. - DAVAÏ is assumed to be the appropriate and sufficient test-bed for providing both a common definition of the CSC components and common tools for testing, at the start of this task. While the complexity of the CSC definitions increases with time, specific tools might have to be developed for testing the CSCs (ie beyond the scope of what DAVAÏ can offer at the level of technical QA)	PM, CSC-Leaders, IL, SysAL, other integration or system involved staff (COOPE/D, LACE/ASC, SysExperts etc.)	

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
2.T.1	IL, SysAL, ClFi	Accessible Forge	
2.T.2	IL/AlMa	Davaï components	
2.T.3	IL, SysAL	Bundling doc & tools	
2.T.6	SysAL, PaPo, ClFi	Wiki	

ACCORD WorkPackage description : COM3.1

WP number	Name of WP
COM3.1	Maintenance and Partners' implementations of the ACCORD system
WP main editor	**Claude Fischer and Maria Derkova (CNA)**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MaDe, OlSp	Maria Derkova (1), Oldrich Spaniel (2)	SHMU Slovakia	3
GhFa, OlNu, FlSu, ErWa, OlJa, YaSe, MaPl, NiMa	Ghislain Faure (1.5), Olivier Nussier (1.5), Florian Suzat (3), Eric Wattrelot, (1.5), Olivier Jaron (1), Yann Seity (1), Matthieu Plu (1), Nicolas Marie (2), Pascal Lamboley (6), Véronique Mathiot (9)	Météo-France	27.5
all	Belgium team: Alex Deckmyn, Michiel Vanginderachter	RMI Belgium	3
all	Croatia team - Suzana Panezic (1), Mario Hrastinski (1), Antonio Stanesic (1), Ana Šljivić (1)	DHMZ Croatia	4
all	Slovenia team	ARSO Slovenia	4
all	Czech Republic team: Petra Smolikova (1.5), Antonín Bučánek (1.5), Alena Trojáková (1.5), Ján MašeK (1.5), Radmila Brožková (2), PetrJaneček (6)	CHMI Czech	14
all	Austria team - FlMe 1, PhSc 0,5, ClWa 1, FlWe 2, ChWi 1.5, StSc 1	ZAMG Austria	7
all	Hungary team	OMSZ Hungary	8
all	Romania team: Mirela Pietrisi (2pm - COM3.1.2), Alexandra Craciun (1pm - COM3.1.2)	Meteo Romania	3
all	Morocco team	Maroc Meteo	3
all	Tunisia team: Hajer Dhouioui, Rahma Ben Romdhane, Wafa Khalfaoui, Haythem Belghrissi	INM Tunisia	4
all	Turkey team	MGM Turkey	
all	Bulgaria team	NIMH Bulgaria	4
all	Poland team	IMGW Poland	
all	Portugal team: Vanda Costa, Manuel Lopes, João Rio, Maria Monteiro	IPMA Portugal	6
all	Algeria team	ONM Algeria	4
SysTeam	HeFe	DMI Denmark	1.5
SysTeam		ESTEA Estonia	2
SysTeam		FMI Finland	
SysTeam		IMO Iceland	6
SysTeam		MET Eireann	
SysTeam		KNMI Netherlands	
SysTeam		MET Norway	8
SysTeam		AEMET Spain	
SysTeam		SMHI Sweden	
SysTeam		LHMS Lithuania	4

WP objectives

The aim of the WP is to support and coordinate the activities leading to the implementation of new code versions at the Members' NMS:
- distribute relevant technical information among Partners, provide basic help for local installation or distribute specific tasks when required
- collect reported problems and their solutions and assist in preparation of code bugfixes
- follow the contributions to new code releases

These efforts involve technical coordination tasks in accordance with the ToRs of the Coordinator for Networking Activities (CNA). They are done in close collaboration with PM and the Integration and System Area Leaders. In addition, communication and coordination with the LTMs and other specific contacts in sub-groups are needed (eg. LACE ASC, HIRLAM System Experts etc.).

In parallel a coordination of operational changes between MF and the other Partners is needed. This activity encompasses the supervision of changes in the preparation of input files necessary for the Members, in order to run local versions of the System (for example: coupling files, climatological files).

Reporting and feedback from the results of installing new code versions locally, or evaluating the quality of a new System version, are highly encouraged and will be monitored at best (PM, CNA, MQA Area Leader). Some executive summary reporting to relevant bodies will be prepared.
Most of the efforts described in this WP will be monitored and accounted for in the CEpQA item required by the ACCORD/MoU (except tasks COM3.1-3 that belong to the ToRs of CNA).

The complete meteorological quality assurance efforts (scores, e-suite context, specific case studies) is part of the MQA3 WP, under the supervision of the MQA Area Leader (note that these efforts also are accounted for in CEpQA, though they are described in a different Section of the RWP).
Please do not refer to COM3.1.6 anymore in 2022 (this task is only kept for ... referring explicitly to MQA3 !).

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 LTMs and other System relevant contacts (Local Team System Representatives, LACE and Hirlam System Experts etc.) 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	Early installation of a new T-cycle version (or a new version of an existing T-cycle) on any platform (local, ECMWF etc.), evaluating and fixing troubleshooting problems (fixes in the codes, early tuning to ensure proper execution of the codes etc.). Perform early meteorological validation. The level of common support by ACCORD is provided for the definitions of the CSCs, which may evolve with time (CSC: Arome, Harmonie-Arome, Alaro / Link with COM2.T.A). Feedback needs to be provided to CNA: - on technical problems or issues with bugfixes that teams might have encountered - on the final results of validation on the local platform, including results on performances (ie compute/execution times, memory use) Possibly exchange with other teams porting the same new code version, under the supervision of CNA. Think of preparing some formal feedback to the consortium, in form of a note, a contribution to the newsletter, a poster at the ASW etc. This task is in practice realized with different work organizations depending on the teams (local individual work or grouping): - MF: the intermediate step between the declaration of the T-cycle and the first validation in preparation of an e-suite version (so-called "blank" e-suite version, containing no specific e-suite contribution) - Hirlam System Experts team: upload and installation of a T-cycle into the Harmonie environment & early testing in preparation of a H-cycle (Harmonie-Arome CSC) - LACE: support provided by the LACE ASC or LACE Data Manager to other teams for their local installation - ACCORD teams in general: local installation of a T-cycle version	all local staff involved; SysTeam; LTMs	t-code or note
COM3.1.3	Collection of reported problems from COM3.1.1 and their solutions and contribution to the preparation of the bugfix for the export code	MaDe, OlSp	t-code
COM3.1.4	Preparation and chairmanship of the LTMs meetings	MaDe	non-t-code (meeting)
COM3.1.5	Coordination of MF operational changes with Partners	**GhFa**, MaPl, MaDe	
COM3.1.6	*Quality assessment of operational suites => **moved to MQA3***		
COM3.1.7	Maintenance and troubleshooting support for any CSCs or for local operational versions, when there is a feedback provided to the ACCORD consortium (eg. a code fix is needed and should be shared, or a specific tuning or use of option is explained for the other teams). Feedback and liaison is expected via CNA and System people. This task will in practice be organized in a flexible way, taking into account the organization of this effort across groups (eg. Hirlam System Experts, LACE ASC and Data Manager etc.).	all local teams; SysTeam; CNA	t-code or note
COM3.1.8	Backup and troubleshooting System guidelines from Operations to Research (and vice versa) to ensure smooth operational running. The level of common support in ACCORD will refer to codes, parts of scripts or other input data that is shared at consortium level. Therefore, it is expected that this task and its scope will grow with time as more common codes will be shared, and the definition of the CSCs evolve (typically, more functions or larger pieces of common scripts). It is expected that the issues handled in this task are documented and information is made available to all the teams, via coordination by CNA. Hirlam system O2R/R2O activities that add on (for specific components of the Harmonie-Arome Reference System) are described in SY2.	all local staff; SysTeam; CNA	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	CY48T1 in 2022
COM3.1.3	MaDe (+ HIRLAM PL for system + RC LACE ASC)	list of code fixes and update of exported T-cycle version	CY46T1_bf CY48T1 in 2022
COM3.1.7	MaDe (with CSC Leaders, Integration Leader or System Area Leader), DaSa	"late" code fixes for "old" T-cycles; specific tuning parameters (namelists); H-cycles	CY46T1_bf CY48T1 in 2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM3.1.1	MaDe	report	2022
COM3.1.2	MaDe	report	2022
COM3.1.4	MaDe (with PM & CSS)	minutes of meeting	2/year @LTM meeting
COM3.1.7	DaSa & MaDe & LTMs	reports	ASW presentation or poster or newsletter article
COM3.1.8	DaSa & MaDe & LTMs	reports	ASW presentation or poster or newsletter article

ACCORD WorkPackage description : COM3.3

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
CIFi	Claude Fischer (0 - if any, this will be part of the PM activity reporting)	Météo-France	
GMAP	volunteering GMAP staff for the regular "SistemD" tutorials (the manpower is assumed to be committed through the DA WPs)	Météo-France	
GMAP	GMAP staff involved in the preparation and supervision of the DA code training days (the manpower is assumed to be committed through the DA WPs)	Météo-France	

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 ACCORD NWP 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".	CIFi	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 ?). There also is a risk that these training days must be delayed to 2022.	GMAP, others	tutorial material

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
COM3.3.3	GMAP	tutorial material	June 2022 (if delayed)

ACCORD WorkPackage description : COM3.4

WP number	Name of WP
COM3.4	Attendance and preparation of ASW & EWGLAM
WP main editor	**Claude Fischer, Jeanette Onvlee, Eric Bazile and Martina Tudor**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PM	Programme Manager (accounted for in MNGT4)	Météo-France	
CSS	Consortium Scientific Secretary (accounted for in MNGT4)	Météo-France	
LocOrg	Local Organizer of ASW (or EWGLAM venue if in an ACCORD country)	ARSO Slovenia	1
CNA	Coordinator for Networking Activities	SHMU Slovakia	
LTMs	Local Team Manager or other staff, committed in MNGT4		

WP objectives

There are two yearly meetings where many of the ACCORD staff meet and which are also used for coordination purposes within ACCORD: 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. Conversely, 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

ACCORD WorkPackage description : SPTR

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
DaDe, PiTe	Daan Degrauwe (9), Piet Termonia	RMI Belgium	13
ThBu, PhMa, MF	Thomas Burgot (9) , Philippe Marguinaud (6) , Florian Suzat (1), other MF/GMAP staff from the dynamics/system (ALGO) and physics (PROC) teams	Météo-France	16
CoCl	Colm Clancy	MET Eireann	2
RoMy	Rolf Myhre, additional Metno staffing	MET Norway	12

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 ACCORD 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.
Given the close relation of the ACCORD codes to ECMWF's IFS code and the fact that ECMWF is putting big efforts in the topic of code adaptation, we (ACCORD) will more or less follow ECMWF's plans in this area.
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 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 ACCORD community in the past since its early design stage. We will follow the new developments in Atlas and investigate their use in ACCORD applications.
The main task in this work package will be to prepare and carry out the porting of the ACCORD codes on accelerators such as GPU's. Again following ECMWF's plans, different porting strategies are envisaged for different parts of the codes. For the spectral transforms, which are well-delineated and slowly-evolving, yet crucial for performance, a manual hardware-specific porting and optimization is targeted. For the case of the physics parameterizations, which cover a large part of the code base, and which are evolving much faster than e.g. the spectral transforms, the application of source-to-source transformation tools will be pursued. Finally, the flexibility of the control routines needs to be improved through the introduction of smart (device-aware) state variable structures.
In 2022 the focus will be on the introduction of smart data structures and the openACC/openMP based code adaptations (SPTR3). Continous developments, such as for instance Atlas, will continue at a pace that will follow the developments of FVM within ECMWF.
An important issue to address is he understaffing of this WP. The workplan of the DestinE Extremes project will be aligned with the ACCORD workplan and substantial man power will be requested to complement the above indicated 43 PM. Regular meetings will be organized with ECMWF to keep the developments and plans in accordance.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SPTR1	Prepare ACCORD codes for porting to GPU's. Regular meetings will be organized with ECMWF to ensure that the ACCORD activities stay aligned with the ones of ECMWF.	PhMa, DaDe	t-code
SPTR1.1	Further optimize biFourier spectral transforms by minimizing host-device data transfers and potentially overlapping MPI communications with computations. For the time being, the GPU version will be based on CUDA (or HIP, for AMD machines).	PhMa, ThBu	
SPTR1.2	Gridpoint column calculations (mainly physical parameterizations, but also some dynamics) will be ported using source-to-source transformation tools, which annotate the code with OpenACC (or OpenMP5) directives. It will be investigated if Loki (the tool being developed at ECMWF for this task) satisfies the needs of ACCORD. Also the use of custom scripts, which have been applied already with success to some parameterizations, will be explored further. An important constraint is that the vectorization and the performance on CPU-only machines should not be affected in a negative way.	PhMa, DaDe, RoMy	
SPTR1.3	A strict distinction will be enforced between gridpoint control routines and calculation routines (physics parameterizations).The dataflow between control routines and calculation routines will be reorganized using smart state variable structures based on the ones used in ECMWF physics in cy48. Some preparatory cleaning is required to remove calculations from the control routines and to reduce their overall complexity. This work will require a very strict validation for the different CSC's and will involve physics experts from all CSC's.	PhMa, DaDe, MF ALGO/PROC teams, other physics experts	
SPTR1.4	Follow developments at ECMWF concerning the porting of the semi-Lagrangian advection scheme to GPU's and prepare for the adaptation of these developments for the LAM case.		

SPTR2	Continuous Atlas developments. These will continue but with low priority. Atlas can be considered as a tool with various roles, e.g. interpolation activities, grid/mesh generation, data governance and handling. The focus for 2022 will be on features that are required for SPTR2 (multi-IO server), DY2 (FVM operators) and DY3 (stencil FD operators). In 2022, ECMWF plans the completion of the FVM dynamical core, using a 3D unstructured grid with an additional limited-area model (LAM) configuration, that is fully implemented in Python with an embedded DSL. This LAM version will be tested.	DaDe, CoCl	code in Atlas github repository
SPTR3	Adapt the IO server or its ECMWF extension called multIO to Atlas; optimize I/O using Atlas tools	**PhMa**	t-code
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. Development of webinars, where the management of it will later be transferred to COM3.3.*	DaDe, Cocl	training material
SPTR5	Seek to get access to a diversity of platforms (NVIDIA GPU's, AMD GPU's, ARM processors, vector accelerators). Experiments on these platforms would be done using dwarfs (e.g. stand-alone driver for single parameterization, bifourier spectral transform) or prototype codes (stripped-down version of full code).	**FlSu**	documentation

t-code deliverables

Task	Responsible	Cycle	Time
SPTR1	PhMa	49t1	end of 2022
SPTR3	PhMa		

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SPTR2	DaDe	code	
SPTR4	PiTe, DaDe	documentation, webinar	
SPTR5	FlSu	documentation	

ACCORD WorkPackage description : ML1

WP number	Name of WP
ML1	Use of ML for ACCORD NWP aspects
WP main editor	**Claude Fischer, Jeanette Onvlee, Eric Bazile and Martina Tudor**

Table of participants

(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)

Participant Abbreviation	Participant	Institute	PersonMonth
PeUk	Peter Ukkonen	DMI Denmark	2
MeSh	Metodija Shapkalijavski (ML1.8)	SMHI Sweden	1
PaMe, JeBo	Paulo Medeiros, Jelena Bojarova (2.25)	SMHI Sweden	2.25
GeBe,EmGl	Geoffrey Bessardon (1), data science students (*)	MET Eireann	1
MiVa	Michiel Vanginderachter	RMI Belgium	
KiWh, JeOn	Kirien Whan (1), Jeanette Onvlee (0.25)	KNMI Netherlands	1.25
MaTu	Martina Tudor	DHMZ Croatia	0.25
BoBo, MaKo, MaSz	Bogdan Bochenek (1), Marcin Kolonko (1), Malgorzata Szczech (1)	IMGW Poland	3
OlCa, PaCo, ViPo, GaCo, JCCa	Pauline Combarnous (5), Vivien Pourret (0.5), Gabriel Colas (5), Jean-Christophe Calvet (0.5), GMME staff who will replace Olivier Caumont (1)	Météo-France	9
BaAL	BadrEddine Alaoui	Maroc Meteo	3

WP objectives

Machine Learning is becoming an interesting topic in NWP, not only in postprocesssing but also in many other contexts of NWP. There primarily are two strong incentives for considering ML approaches:
1. propose more accurate modeling codes for processes that are physically complex, with a high level of non-linearity for instance
2. propose a cheaper model component in addition or in replacement of a more expensive, physics-based code. The ML code might be more efficient on new HPC architectures (like GPU), so there may be a link with SPTR1

The potential of using Machine Learning (ML) techniques will be evaluated in physics parameterizations. 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.
Another area of increasing interest for ML approaches is data assimilation, where these techniques may be considered for observation pre-processing, data quality control, bias correction, and observation operators. Emulation of parts of radiative transfer obs operator codes by ML are for instance being addressed by several centers (ECMWF, personal comm.). Applications to new observation types (quality control for citizen obs or high density obs) are appearing.
Aspects of machine learning are already present in other parts of the plan, for example in E6 (for ensemble calibration) and E10.2, where machine learing is utilized to reproduce systematic model errors.

Note that the full scope of post-processing is NOT taken into account in this specific WP. The reason for this choice is that there already is a large variety of local efforts taking place on using ML/DL for post-processing, from computing new fields (in addition to those computed and output by the ACCORD codes) to calibration for production. The "frontier" between model-derived fields computed from model state variables and those adapted by downstream production applications also is hard to define.
The scope of this WP has been restricted to the study of the potential impact of ML techniques with the analysis and forecast model (e.g. physics parametrizations, obs operators), and on diagnostic fields computed in-line during the model run (eg. hydrometeors fields either computed from a physics-aware scheme or from a ML data-trained scheme, as a hypothetical example !).

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
ML1.1	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, MiVa	Report
ML1.2	Use ML techniques to tune physical parameters , e.g. surface parameters	GeBe, MaTu, MeSh, PaMe, BoBo, MaKo, MaSz	Report and/or code
ML1.3	Use ML to improve physiographic data, e.g. ECOCLIMAP 2nd gen. data	GeBe, EmGl	Report and code
ML1.4	Lightning Imager obs operator	PaCo, GMME	Report
ML1.5	Complex error correction as a step of NetAtmo obs pre-treatment (in view of their assimilation)	ViPo, GMME	Report
ML1.6	The objective of this PhD work is to develop the assimilation of level 1 products in the ISBA land surface model within the SURFEX modelling platform (LDAS-Monde, Albergel etal. 2017). Observation operators will be developed using artificial intelligence (e.g. Rodríguez-Fernández et al., 2019) and will concern microwave level 1 products from SMOS, ASCAT, and Sentinel-1. A new global land reanalysis will be produced as well.	GaCo, JCCa	Report

ML1.7	ACCORD Working Group tasked to define problems and datasets needed to tackle them in machine learning way. For further details, refer to ToRs of this WG-ML. Tasks ML1.8 and ML1.9 will derive from the outcomes of this task ML1.7.	WG-ML	Report, roadmap
ML1.8	Explore methods applicable for different problems. For DA, link with DA2.8.	WG-ML	Report
ML1.9	Describe the datasets for training ML algorithms in specific problems	WG-ML	Report, dataset description

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code del deliverables

Task	Responsible	Type of deliverable	Time
ML1.1	PeUk	Report including results	December 2021
ML1.2	AnSt, GeGe, MaTu, MeSh, PaMe	Report and/or code	December 2021
ML1.3	GeBe, EmGl	Report and Code	December 2021
ML1.4	GMME	Report (PhD!)	End 2023
ML1.5	GMME	Report	End 2022
ML1.6	JCCa	Report (PhD!)	End 2023
ML1.7		Report	End 2021 or Q1 2022

ACCORD WorkPackage description : HR1

WP number	Name of WP
HR1	Sub-km modelling
WP main editor	**Jeanette Onvlee, Eric Bazile and Martina Tudor**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
JaCa, DMP, DaSu	Javier Calvo (1.5), Daniel Martin Perez (1.0), David Suarez	AEMET Spain	2.5
JuCe	Jure Cedilnik	ARSO Slovenia	1
PeSm	Petra Smolíková	CHMI Czech	
AnSi	André Simon	SHMU Slovakia	3
MaTu	Martina Tudor (1)	DHMZ Croatia	1
XiYa	Xiaohua Yang (1), Daniel Santos	DMI Denmark	1
IvAn, AhMe	Ivar Ansper (1), Ahto Mets (0.5), Alina Lerner (0.5)	ESTEA Estonia	2
PiSe, MaSz, MaKo	Piotr Sekula (1), Malgorzata Szczech (1), Marcin Kolonko (1)	IMGW Poland	3
NaTh	Natalie Theeuwes	KNMI Netherlands	1.5
MaNa	Marass Najla	Maroc Meteo	1
CoCl, JaFa	Colm Clancy (1.5), James Fannon (1.5)	MET Eireann	3
EMSa	Eirik Mikal Samuelsen	Met Norway	0
RaHo, SaAn, YaSe	Rachel Honnert (3), Salomé Antoine (7), Yann Seity (2): CNRM/GMAP	Météo-France	12
DiRi, BeVi, MaMa, AlDe	Didier Ricard (0.5), Benoît Vié (3.5), Marc Mandement (3), Alan Demortier (5.5): CNRM/GMME	Météo-France	12.5
StSc, SaOs	Stephan Schneider (2), Sandro Oswald (2)	ZAMG Austria	4
SiTh, BoPa, GNPe	Sigurdur Thorsteinsson, Bolli Palmason, Gudrun Nina Petersen	IMO Iceland	3

WP objectives

The main objective is to achieve up-to-date, realistic and affordable research and pre-operational versions of sub-km AROME-France, HARMONIE-AROME and ALARO. Research is now beginning to extend to the hyper-resolution (O(100-200m) horizontal resolution in grid point space) scale. Aspects to be studied are numerical stability, particularly near steep topography; the meteorological and computational effects of using higher order than linear spectral grids; the need to revise or retune physics parametrizations, the settings of horizontal numerical diffusion and SLHD; the provision of adequate physiography data; the availability and quality of observations suitable for the validation of hyper-resolution models; and the validation and optimization of the model for urban environments. 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.
The tasks described here are closely related to the progress made in new dynamics schemes (DY2,3), 3D-physics (PH7), high-resolution physiography (SU5), new observation types (DA4) and suitable new validation and verification techniques for hyper-resolutions (MQA2). In addition to this, options for data assimilation settings, ensemble configurations, and computational efficiency aspects will also be considered. These experiments will be done on several (maritime and continental) test domains.
At sub-km and hyper-resolution scales, we enter the grey-zone of shallow convection and turbulence, and the physics parametrizations will need to be revised and retuned accordingly. Field experiments will be used to validate and optimize aspects such as the microphysics (e.g. SOFOG3D) and the urban description (e.g. the WMO 2024 Paris Olympics project). Attention will be needed for developing computationally affordable 3D-schemes for radiation and turbulence (link with WP PH7). It will be assessed whether or not we run into limitations of our present spectral SISL dynamics (work closely related to the DY2,3 WP's).
Activities will also focus 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. 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 parametrized vertical diffusion will be studied for a range of resolutions.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
HR1.1	Set up dedicated hectometric and hyper-resolution (100-200m horizontal resolution) configurations for all three CSCs. Perform experiments with these configuration on various aspects of model behaviour.	JuCe, BoBo, CoCl, XiYa, DaSu, JaCa, DMP, EMSa, YuBa, NaTh, IvAn, AhMe, AnSi,PiSe, MaSz, MaKo, StSc, SaOs	report
HR1.1.1	Update and improve the AROME-France 500m configuration with and for the fog experiement and for the airport area such as CDG. Continue experiement over the Alps with AROME-200m. Establish hectometric and hyper-resolution Harmonie-Arome model setups for several new domains. Establish a hectometric ALARO model setup that would run dynamical adaptation of wind using the latest export version. This particular configuration uses only turbulence from the physics package, therefore a balance between the turbulent vertical fluxes computed by the physics and horizontal diffusion computed by dynamics (SLHD and numerical) has to be achieved (related to HR1.1.3a).	**RaHo**, **SaAn**, **YaSe**, MaNa,ErBa	namelists
HR1.1.2	For all CSC's, compare the model behaviour for various horizontal/vertical resolutions, and compare the model at various hectometric resolutions against LES and observations. (Related to new high resolution measured data in DA4 and MQA tasks as well as HR1.2).	CoCl, XiYa, DaSu, JaCa, NaTh, IvAn, AhMe, DMP, EMSa, **SaAn, RaHo, YaSe**	report

HR1.1.3	Optimization of dynamics and diffusion settings (valid for all three CSCs if not stated otherwise): 1) Evaluation of Arome-Fr at 500m and hyper-resolutions (200m first) over the Alps, with a focus on model dynamics behaviour in conditions of steep orography 2) Establish an optimal tuning of dynamics and TOUCANS in high-resolution runs of ALARO (preferably extend this work to the other two CSC's). 3) Study the resolved versus sub-grid turbulent kinetic energy spectra in high resolution runs 4) Study SLHD performance at super-resolution aiming to redesign the horizontal/vertical diffusion treatment. 5) Consider the role of horizontal diffusion and SLHD at hectometric scales	DiRi, MaHr, AnSi, PeSm, CoCl, JaFa	report, namelist configurations
HR1.1.4	Optimization/tuning of physics parametrizations for specific configurations and test cases: 1) evaluate AROME-Fr-500m over the Alps and for gust forecasting (in the framework of the TEAMX project), 2) continue the study of the scale aware option for the shallow convection (test on a EUREC4A case in the framework of the Grey-zone project and over the Alps), 3) evaluate the behaviour of AROME-Fr on fog cases of either underestimation or false alarms. Use a purpose-tailored Arome-500m with 156 vertical levels, microphysics observations from the SOFOG3D campaign and LES simulations done at GMME.	**RaHo**, DiRi, **YaSe**, **SaAn**, BeVi, ErBa	report, namelist configurations
HR1.1.5	Investigate aspects of urban modelling at hyper-resolutions; optimize the physiographic data available for several urban areas, engage in ongoing field experiments and projects like the WMO Paris Olympics 2024 project, and try out more advanced parametrizations within the TEB scheme such as the Building Energy Model (BEM).	NaTh, StSc, SaOs	report, namelist configurations
HR1.1.6	Carry out investigations of computational efficiency and possible ways to improve it (e.g. test single vs double resolution, test the effect of single precision in combination with more vertical levels).	CoCl, JaFa	report
HR1.2	Collect and assess the suitability of high resolution observation datasets (near-real-time, e.g. NetAtmo data, or field experiment data) for validation of hectometric models. Consider how to obtain a set of carefully quality-controlled urban stations with known local climate zone characteristics, which may serve as benchmark stations for citizen observations (link with tasks in DA4).	MaMa, StSc, SaOs, AlDe	report, non-t-code
HR1.3	Collect/optimize the model physiographic data for use in hectometric and hyper-resolution configurations (link with SU5)		databases
HR1.4	Develop a methodology for investigation of the validity range of individual physics parameterizations when moving to hectometric hyper-resolution model configurations (details refer to strategy document: http://www.accord-nwp.org/IMG/pdf/strategy.pdf. Collect information on choices and tunings of already tested configurations. Determine the grey zones for each of the parametrisations.	MaTu	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	
HR1.3	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	
HR1.11	MaHr (1), PeSm	report, non-t-code	

ACCORD WorkPackage description : DY1

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

Table of participants

(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)

Participant Abbreviation	Participant	Institute	PersonMonth
FaVo, LuAu, HaPe	Fabrice Voitus (4), Ludovic Auger (1.5), Harold Petithomme (2)	Météo-France	6
PeSm	Petra Smolíková	CHMI Czech	7
JoVi	Jozef Vivoda	SHMU Slovakia	5
AlCr	Alexandra Craciun	Meteo Romania	2
MaHr, AnSl	Mario Hrastinski, Ana Šljivić	DHMZ Croatia	3.5
BoBo, PiSe, GaSt	Bogdan Bochenek, Piotr Sekuła (1.5), Gabriel Stachura (1.5)	IMGW Poland	3
CoCl	Colm Clancy	MET Eireann	2

WP objectives

The modernization of the current hydrostatic and non-hydrostatic dynamical core of the ACCORD 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 ACCORD 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	Dynamic definition of the iterative time schemes: the choice made in the predictor between NESC, SETTLS or combined scheme, 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
DY1.2	Testing of new dynamics options available in cy46T1 : 1) 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. 2) LNUDGW : A new upper absorbing Layer implicitly treated along the lines of the idea of Klemp et al. (2008). This UBC treatment improve the robustness of the model by minimizing reflection of badly resolved fast waves at the top of the model. 3) RSIPRA : An additional SI parameter for hydrostatic surface pressure stabilizing the model above high orography (e.g, Himalaya) where the amount of baric non-linear residuals is significant ($\pi s << \pi s*$). 4) LSILAPL : A more stable formulation for the discrete vertical Laplacian-like SI operator $L*v$, taking in account somehow the extra coupling introduced by the orographic metric terms induced by the terrain-following transformation. (partially coded for VFD in cy48, to be extended to VFE). 5) LSIDDT : This option offers the possibility to build the linear model and (associated vertical parameters defined in the structure YDDYN) "on the fly" (at each time-steps, even at each iterations). ⇒ Refine the definition of SI paratemers taking into account the actual value of some relevant variables (as πs, T, $\nabla\varphi$, $\nabla\pi s$,....) in order to improve robustness and stability of the ICI scheme. 6) On-demand decentering : applied only at the predictor step and only for some specific variables ($\hat{q}$, T,w).	FaVo	t-code

DY1.3	Formulation of Euler equations as the increment of hydrostatic primitive equations. The aim is to add nonhydrostaticity gradually and omit it where numerical stability is questionable (with vertical or time from start dependency). In parallel, the control parameters are introduced in the linear model enabling to modify it after the linearization from the full model aiming on the improved stability (similarly as it was done before for SITR/SITRA parameter). This code is available in cy46T1 and in cy48 for constant control parameters. These new options will be tested on the problematic USA domain and on a very high resolution domain. This has a link with point 3) of DY1.2.	FaVo, JoVi, PeSm	t-code, non-t-code
DY1.4	Implementing (NVDVAR= 5) option for VFE discretization, for a more consistent treatment of the (BBC) bottom boundary condition. (Already coded for VFD in cy48).	FaVo, JoVi, PeSm	t-code, non-t-code
DY1.5	Testing the influence of the definition of vertical coordinate eta on the accuracy of vertical interpolation.	PeSm	non-t-code
DY1.6	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, BoBo, PiSe, GaSt, AnSl	non-t-code
DY1.7	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. (note: this is the task HR1.2 from the RWP-2021, moved to Dynamics)	CoCl, LuAu, HaPe	non-t-code
DY1.8	Development of tools to diagnose energy and entropy in the model system and tuning of TOUCANS (vertical diffusion parametrization scheme) and SLHD (horizontal diffusion scheme) to get a consistent and scale invariant parameterization of mixing processes. Preparation of an experimental setup enabling to test schemes in multiscale environment (the cascade of resolutions 4km, 2km, 1km, 500m on roughly the same territory). Design a method to determine the resolved TKE. 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	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time
DY1.1	AlCr	CY49T1	end 2022
DY1.2	FaVo	CY49T1	end 2022
DY1.3	PeSm	CY49T1	end 2022
DY1.4	FaVo	CY49T1	end 2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY1.3	JoVi, PeSm	Report, scientific paper	end 2022
DY1.4	FaVo, JoVi	Report	end 2022
DY1.5	PeSm	Report	end 2022
DY1.6	MaHr, IvDo, BB, PiSe, GaSt	Report	end 2022
DY1.7	CoCl, LuAu	Report	2022
DY1.8	MaHr, PeSm	Report	2022

ACCORD WorkPackage description : DY2

WP number	Name of WP
DY2	FVM-like solution as an alternative to SISL dynamical core
WP main editor	**Ludovic Auger**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
FaVo	Fabrice Voitus (1)	Météo-France	1
LuAu	Ludovic Auger (0.5)	Météo-France	0.5

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 ACCORD model.
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
DY2.1	On the basis of the latest DSL-based FVM version, a testing of FVM will be performed. Then 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).	FaVo	non-t code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY2.1	FaVo	Documentation	2022

ACCORD 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**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
LuAu, PiBe	Ludovic Auger (1.5) , Pierre Bénard (4)	Météo-France	5.5
DaDe	Daan Degrauwe	RMI Belgium	1

WP objectives

The current semi-implicit semi-lagrangian dynamical core of ACCORD model 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
DY3.1	Further implementation of local operators in our dynamics. The implicit solver has already been successfully performed in grid-point space. Now the goal is to study the possibility to implement a diffusion in gridpoint space. The aim is to identify the parts of the code still using spectral derivatives and get rid of them.	LuAu, DaDe	non-t-code
DY3.2	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	non-t-code
DY3.3	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, PhMa	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DY3.1	LuAu	Documentation	end of 2022
DY3.2	LuAu	Documentation	end of 2022
DY3.3	PiBe	Documentation	end of 2022

ACCORD WorkPackage description : DA1

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
JaSa, PaEs	Jana Sanchez (2), Pau Escriba (1)	AEMET Spain	3
AlTr, AnBu	Alena Trojakova (2), Antonin Bucanek(3)	CHMI Czech	5
EnKe, AnSt, SuPa	Endi Keresturi (0.75), Antonio Stanesic (2.5), Suzana Panezic (1.5)	DHMZ Croatia	4.75
WaKh	Wafa Khalfaoui (1)	INM Tunisia	1
RoRa, MaMi, PeDah,JoBl,OlVi, RoAz	Roger Randriamampianina (0.75), Mate Mile (Arctic-Passion), Per Dahlgren (CARRA, CERRA), Jostein Blyverket (1, MetCoOp), Ole Vignes(1, MetCoOp), Rohallah Azad (MetCoOp)	MET Norway	2.75
PiBr, PhCh, OlGu	Pierre Brousseau (1), Philippe Chambon (3), Oliver Guillet (2), Olivier Coopman (2)	Météo-France	8
MaLi, MaRi, SuHa, JeBo	Magnus Lindskog (1.5), Martin Ridal (0.5), Susanna Hagelin (0.5), JeBo (qCONDOR)	SMHI Sweden	2.5
BeSt	Benedikt Strajnar (1)	ARSO Slovenia	1
MarDer	Maria Derkova (2.5)	SHMU Slovakia	2.5
ErGr	Erik Gregow (2)	FMI Finland	2
GJMa, IsMo	Gert-Jan Marseill (Midas,Replica), Isabel Monteiro	KNMI Netherlands	

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 DA5 (DA5.3) and DA6 (DA6.8).
- 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	Making optimal use of observations taking error characteristics and scale differences between observation and model into account: evaluate scales of variability in mesoscale phenomena; investigate the effective model resolution, optimal scales for superobbing and meaningful scales for analysis updates; develop methodology to account for correlated observation errors, handling of gross errors, analysis and optimisation of error characteristics as well as quality control rejection limits (first-guess check and VarQC, background errors in observation space) and to allow re-linearization, optimal scale for supermodding vs footprint operator. Optimize structure functions generation for assimilation of high-resolution data (sampling on appropriate scales, spectral spin-up, impact of imbalances and numerical noise, size of the extension zone) (See also E10.2.; DA5.1, HR1.1 and HR1.7)	MaRi, RoRa, JaSa, WaKh, MaMi, OlGu, PaEs, ErGr, JoBl,OlVi, RoAz,MaMi,PeDah, GJMa,MaLi, PiBr	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: Find the best solution for taking the large scales into account (Jk, LSMIX, via preconditioning, pre-mixed penalty-free Jk, BendVar, ...). Consider increased lateral boundary condition coupling frequency.	EnKe, AnSt, MaDah, XiYa	Scientific note
DA1.4.1-3	Observing system simulation experiments: 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. 3)Set-up a new framework for OSSEs with full AROME observing system (including radar data) for the preparation of future observations (ex. IRS/MTG, AWS) in AROME 3D-Var.	SuHa,MaMi,GJMa, PhCh, OlCo	Scientific note

DA1.5	Maintenance and evolution of the state-of-art ACCORD [3D-Var/BlendVar] assimilation cycles: follow-on changes of e-suites, exchange about scientific results between ACCORD partners. Maintenance and coordination of the reanalysis script system, and organise meetings to promote it.	PhCh, RoRa, BeSt, AlTr, AnBu, AnSt, PeDah, MarDer, SuPa, MaLi	Scientific note

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA1.1	MaMi,FlMe, PhSc (RT11)	Code and report for handling observations in different scales.	end 2022
DA1.2	AnBu,MaLi,PiBr (ST8)	Report on impact of differently computed B matrices	end 2022
DA1.3	OVi,AnBu (RT4)	Evaluation of possible solution for use in the reference system about large scale consideration.	end 2022
DA1.4	PhCh, IsMo (RT5)	Specific Harmonie branch ready for OSSE.	end 2022
DA1.5	PiBr, MaLi, BeSt, AlTr	Technical report	end 2022

ACCORD WorkPackage description : DA2

WP number	Name of WP
DA2	Development of flow-dependent algorithms
WP main editor	**Roger Randriamampianina, Loïk Berre, Magnus Lindskog**

Table of participants *(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)*

Participant Abbreviation	Participant	Institute	PersonMonth
PaEs, CaGe, JaSa	Pau Escriba (3) , Carlos Geijo (1), Jana Sanchez (3)	AEMET Spain	7
KaHi	Kasper Hintz (1)	DMI Denmark	1
JaBa, IsMo	Jan Barkmeijer (2), Isabel Monteiro (2)	KNMI Netherlands	4
EoHa, EoWh	Eoghan Harney, Eoin Whelan (1)	MET Eireann	1
RoSt, RoRa, RoAz, OlVi, NN	Roel Stappers (H2O), Roger Randriamampianina (0.75), Roohollah Azad (MetCoOp), Ole Vignes (1), NN	MET Norway	1.75
LoBe, NiGi, CeLo, YaMi, PiBr, EtAr, OlGu, MaDe, VaVo	Loïk Berre (1), Nicole Girardot (7), Cécile Loo (4), Pierre Brousseau (2), Etienne Arbogast (3), Oliver Guillet (3), Valérie Vogt (2)	Météo-France	18.5
JeBo, SuHa, MaLi, PaMe, ToLa	Jelena Bojarova (qCONDOR), Magnus Lindskog (2), Paulo Medeiros (1.5), Tomas Landelius, Martin Ridal (0.5)	SMHI Sweden	4
FaSi	Fabiola Silva (1, MIDAS)	IPMA Portugal	1
NiGu	Nils Gustafsson (qCONDOR, HIRLAM consultant)	(not relevant)	
FlMe	Florian Meier (2.5)	ZAMG Austria	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, EnVar. For EnVar, two versions are likely to be explored based on recently published papers. Ensemble perturbations for EnVar are most often provided by an EDA approach, whose scientific developments are pursued ; elements of an LETKF scheme may also be considered. 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 and preconditioning; optimize 4D-Var configuration (length of assimilation, observation windows that allows also overlap (see also DA5.2), 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 (ex. explore double vs single precision) (see also SY1); Exploit the benefit of tendency increments and high spatial and temporal observations (ex. Mode-S and MTG-IRS); compare the performance and accuracy of 4D-Var with that of nowcasting applications; control the use of lateral boundary conditions and larger extension zone setups.	MaLi, RoAz, JaSa, WaKh, OlGu, PaMa, EoHa, EoWh, PaEs, JaBa, FaSi, IsMo, NiGu, OlVi, RoRa, MaRi, CeLo	Code and scientific note
DA2.2	EDA and its use for EnVar in OOPS : scientific improvements in EDA systems (regional and global), e.g. related to ensemble size and model perturbations. Optimize use of EDA perturbations in 3DEnVar and 4DEnVar within OOPS (see also task DA6.8 for "EnVar in OOPS").	LoBe, NiGi, CeLo, OlGu, VaVo, PiBr, EtAr, FlMe	code and scientific notes
DA2.3	Ensemble initial perturbation: Evaluate performance of Hybrid EnVar 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
DA2.4	Start to enhance HybridEnVar formulations with a particle filter like functionality to allow more efficient use of observations in presence of non-Gaussian and non-linear uncertainties.	JeBo	code and scientific notes
DA2.5	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. (also see E10.3)	PaEs	code and scientific notes
DA2.6	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	
DA2.7	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

DA2.8	Explore machine learning approaches in data assimilation. Link with ML1.8.	PaMe, KaHi, JaBa, ToLa, JeBo, NN	Scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA2.1	JaBa, RoSt (RT3)	CY47 or later	2019-2022
DA2.2	LoBe, PBr, RoSt (RT1)	prototyping now in CY46T1, porting to CY48T1 on its way.	2018-2022
DA2.3	JeBo, RoRa	CY47 or later	2020-2022
DA2.6	RoSt (RT9)	CY48 or later	2021-2023

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA2.1	OlVi, MaLi, JaSa, PaEs	update of 4D-Var script and namelists for operational application	2019-2022
DA2.2	LoBe	scientific papers about progress with OOPS/EnVar	end 2022
DA2.3	JeBo	update of Harmonie script and namelists and report.	Harmonie scripts and namelists updated. Testing will continue in 2022
DA2.4	LoBe, PiBr, YaMi	1)scientific papers, namelists for the MF suites; 2)mirror suites on MF's new HPC	end 2022
DA2.5	PaEs	Scientific note	end 2022
DA2.7	CaGe	Code and Scientific note	end 2022
DA2.8	PaMe, JeBo (RT12)	Scientific note on the prepared data, tested ML approaches and the trained approaches	end 2022

ACCORD WorkPackage description : DA3

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

Table of participants

(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)

Participant Abbreviation	Participant	Institute	PersonMonth
JoCa, MaDi, Jasa, PaEs	Joan Campins(2), Maria Diez(2.5), Jana Sanchez (2)	AEMET Spain	6.5
BeSt, PeSm, JuCe	Benedikt Strajnar (2), Peter Smerkol (1), Jure Cedilnik (1)	ARSO Slovenia	4
AnBu, AlTr	Antonin Bucanek (5), Alena Trojakova (3)	CHMI Czech	8
AnSt, SuPa	Antonio Stanesic (1), Suzana Panezić (3)	DHMZ Croatia	4
MaDah, HeVe,BjAm	Mats Dahlbom(2.5), Henrik Vedel(0.5), BjAm(1)	DMI Denmark	4
DaSch, ReEr	David Schönach (1.75), Reima Eresmaa (1.75)	FMI Finland	3.5
SiTh	Sigurdur Thorsteinsson (2)	IMO Iceland	2
HaBe, WaKh	Haythem Belgrissi (2), Wafa Khalfaoui (1)	INM Tunisia	3
VaCo, MaMo	Vanda Costa(2.5), Maria Monteiro (1.5)	IPMA Portugal	4
SdH, WiVe, JaBa, IsMo,GJMa	Siebren de Haan(2), Isabel Monteiro (4),Gert-Jan Marseill (Midas)	KNMI Netherlands	6
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui	Maroc Meteo	4
RoDa, EoHa,EoWh	Ronan Darcy (1), Eoghan Harney (1.5), Eoin Wheelan(0.75)	MET Eireann	3.25
MaMi, RoRa, PeDah,JoBl,RoAz, StGu,RoSt	Máté Mile (AWS), Roger Randriamampianina (0.75), Per Dahgren (CARRA, CERRA), Jostein Blyverket(MetCoOp), Roohollah Azad (MetCoOp), Stephanie Guedj(H20),Roel Stappers(H20)	MET Norway	0.75
NaFo, EtVi, PaMo, ViPo, ErWa, MaMa, ChPa, OlAu, MaBo, PhCh, ALDo	Nadia Fourrié (4), Ethel Villeneuve (2), Patrick Moll (2), Vivien Pourret (5), Maud Martet (3), Christophe Payan (5), Olivier Audouin (7), Mary Borderies (2), Philippe Chambon (2), Anne-Lise Dhomps (1.5)	Météo-France	25.25
YeCe	Yelis Cengiz (3)	MGM Turkey	3
ZsKo, HeKo, KrSz, GaTo	Zsofia Kocsis (1), Helga Kollathne Toth (0.5), Kristof Szanyi (5), Gabriella Toth (2)	OMSZ Hungary	8.5
GhCh, MOAM	Ghiles Chemrouk (2), Mohand Ouali Ait Meziane (2)	ONM Algeria	4
MaDe,MiNe, MaIm, JoVi	Maria Derkova (1), Michal Nestiak (3), Martin Imrisek (2), Jozef Vivoda (1)	SHMU Slovakia	7
MaLi, MaRi, GuHa	Magnus Lindskog (AWS, CAISA), Martin Ridal(1.75) (MetCoOp), Günther Haase(0.75), Magnus Lindskog (0.5)	SMHI Sweden	3
FlMe, FlWe	Florian Meier (4.5), Florain Weidle (3.5)	ZAMG Austria	8
AlDu	Alina Dumitru (1)	Meteo Romania	1
MSG, GaSt	Malgorzata Szczech-Gajewska	IMGW Poland	1
AlDe, IdDe	Alex Deckmyn (1), Idir Dehmous (3)	RMI Belgium	4

WP objectives

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

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
DA3.1	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, MaMa, ZaSa, JaBa, JaSa, BeSt, PeSm, ViSv, KrSz, DuAk, EoHa, SuPa, MaMo, JoVi, MSG, GaSt, DuAk, FiMe,JaSa, GuHa	T-codes and scientific note
DA3.2	Observation from moving platforms: 1) *Aircraft based observations (ABO):* assist implement Mode-S wind and temperature (EHS and MRAR) as well as humidity (E/T-AMDAR) pre-processing; refine quality control, thinning/super-obbing; evaluate VarBC for ABO; impact assessment ; 2) *GNSS-ZTD from trains:* quality control, thinning/super-obbing; work out and evaluate a VarBC solution. (See also DA1.1 about correlated observation errors)	JK, SdH, RoRa, FlMe, ViPo, MaRi, MaDe, FiMe, MaDi,LeDC, AlDe, IdDe, GaTo, KaCa,EoWh,RoAz, JaSa,BjAm	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; test feasibility and impact of InSAR delay assimilation from Sentinel-1 with ZTD operator; refine white- or blacklisting of GNSS stations and use of VarBC; conduct impact study; apply with 4D-Var.	JaSa, SiTh, MaLi,MaRi, HeVe, PaMo, MaIm, FaHd, BeSt, MiIm, FlMe,LeDC, AlDe, IdDe, RoDa, SuPa, GhCh, FiMe, FiWe, AnSt	T-codes and scientific note
DA3.4	Scatterometer winds: Assist the assimilation of scatterometer data; Optimize settings for update frequency, 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, VaCo, ChPa, IsMo,GJMa, ALDo*	T-codes and scientific note
DA3.5	Atmospheric Motion Vectors (AMV): Assist the implementation of both locally (NWCSAF HRW software) and EUMETSAT generated AMV's; elaborate the blacklisting procedure.	FM, MMi, DaSch, TL, ZsKo, HeKo, RoRa, PeDah, YeCe,EoWh	T-codes and scientific note
DA3.6.1-3	Clear-sky radiances: 1) Seviri, 2) IASI and CrIS, and 3) ATOVS, ATMS, and MWHS: Explore new cycling strategy for VarBC coefficients. 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. Improve the implementation instruction for radiance assimilation. Revise the blacklisting and screening processes for SEVIRI at large zenith angles.	MaMo, MaDah, SiTh, MaDi, JoCa, WaKh, HaBe, MaLi, MaRi RoRa, ReEr, MOAM, DaSch, IsMo, JoBl, Pedah, StGu,RoSt, NaFo, OlAu, MaBo, PhCh,	T-codes and scientific note
DA3.7	Cloud-affected radiances: synergy between infra-red and micro-wave radiometers	EtVi, NaFo, PhCh	T-codes and scientific note
DA3.8	Assist local implementation of high-resolution ascent and decent radiosondes: optimize local pre-processing, extend observation operator.	MaDe,MaDi,EoWh	T-codes and scientific note.
DA3.9	Surface pressure observations: Address quality control and bias correction; Perform impact assessment; promote data exchange between NMS's	RoRa,RoSt, MaRi, MiNe, SiTh, EoWh	T-codes and scientific note
DA3.10	Wind profilers: Assimilation of sodar wind observations. Assess the quality and perform impact study.	JuCe	T-codes and scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA3.1	MaMa,JaSa, AlTr (RT13 / ST5)	CY48T1 or later	end 2022
DA3.2	ReEr, JaSa (RT7 / ST1)	CY48T1 or later	end 2022
DA3.3	JaSa, AlTr (RT13 / ST5	CY48T1 or later	end 2022
DA3.4	MaMi, MaDah, FlMe, PhSc (RT11 / ST6)	CY48T1 or later	end 2022
DA3.5	MaMi, MaDah (ST6)	CY48T1 or later	end 2022
DA3.6.1-3	PhCh, RoRa (ST7)	CY48T1 or later	end 2022
DA3.7	PhCh, RoRa (ST7)	CY48T1 or later	end 2022
DA3.8	EoWh,AlTr (ST3)	CY48T1 or later	end 2022
DA3.10	MaMi, MaDah (ST6)	CY48T1 or later	end 2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA3.1	MaMa,JaSa, AlTr (RT13 / ST5)	Common pre-processing and Bator for (OPERA) radar data.	end 2022
DA3.2	ReEr, JaSa (RT7 / ST1)	Report on the observation error characteristics for moving platform	end 2022
DA3.3	JaSa, AlTr (RT13 / ST5)	Report about the impact assessment	end 2022
DA3.4	MaMi, MaDah, FlMe, PhSc (RT11 / ST6)	Report about the implementation of scatterometer data from various satellites	end 2022
DA3.5	MaMi, MaDah (ST6)	Report about local AMV implementation	end 2022
DA3.6.1-3	PhCh, RoRa (ST7)	Report from extended and enhanced use of clear-sky radiances	end2022
DA3.9	EoWh, AlTr, MaMi, FlMe,PhSc (RT11 / ST3)	Report about system (scripts and namelist) update and impact assessment	end 2022

ACCORD WorkPackage description : DA4

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

Table of participants *(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)*

Participant Abbreviation	Participant	Institute	PersonMonth
KaHi,HeVe,BjAm, MaDah(1)	Kasper Hintz (1), Henrik Vedel, BjAm(1), MaDah(1)	DMI Denmark	3
CdB, SdH, JaBa, IsMo,GJMa	Cisco de Bruijn (1), Siebren de Haan (0.5), Isabel Monteiro (2),Gert-Jan Marseille (Midas)	KNMI Netherlands	3.5
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui	Maroc Meteo	4
JaSa,JoCa	JaSa(1),Joan Campins (0.5)	AEMET Spain	1.5
RoDa, EoWh	Ronan Darcy, Eoin Whelan (0.25)	MET Eireann	0.25
MaLi, SuHa, MaRi, PaMe, MaRi	Magnus Lindskog (AWS, CLOUDSAT), Susanna Hagelin (1.25) (Aeolus, AWS), Paulo Medeiros (1.75), Martin Ridal (1) (Aeolus), Magnus Lindskog (1)	SMHI Sweden	5
RoRa, RoAz, RoSt, MaMi	Roger Randriamampianina (0.75), Roohollah Azad (AROME Arctic, external proj.),Máté Mile (AWS)	MET Norway	0.75
ReEr, DaSch	Reima Eresmaa (0.25,AWS),David Schönach (1.5,AWS)	FMI Finland	1.75
ErWa, PhCh, FaDu, ViPo, JFM, MaBa, IbSe, OlCo, ClLa, RoMa, MaBo, PaCo, AlDe, RoMa2, DoRa, 2 NN-OBS MaMa, AlDe	Maud Martet (7), Philippe Chambon (3), Vivien Pourret (3), Jean-François Mahfouf (1), Marylis Barreyat (9), Ibrahim Seck (1), Olivier Coopmann (9), Clément Laval (5.5), Rohit Mangla (5.5), Marie Borderie (6), Pauline Combarnous (6), Robin Marty (5.5), Dominique Raspaud (3), Ethel Villeneuve (4), 2 new people in GMAP/OBS team (3 and 4 months in 2022) Marc Mandement (3), Alan Demortier (5.5)	Météo-France	73.75
MOAM	Mohand Ouali Ait Meziane (2)	ONM Algeria	2
PhSc	Phillip Scheffknecht (6)	ZAMG Austria	6
BeSt, PeSm	Benedikt Strajnar (1), Peter Smerkol (2)	ARSO Slovenia	3
MaIm, MiNe	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 CY46/48/49). 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,HeVe	Codes and scientific note
DA4.3	GNSS ZTD horizontal gradients: Perform impact studies with data provided by IGN.	FaHd	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, MaRi, MaMa, AlDe , RoDa, PaMe, FiMe, MaRi, KaHi, AlDe, MiNe	Codes and scientific note
DA4.5	Observation from moving platforms: 1) Pressure observations from smartphones: quality control, thinning/super-obbing; work out and evaluate a VarBC solution; 2) Observations from cars: quality control, thinning/super-obbing; work out and evaluate a VarBC solution.		
DA4.6.1-8	Future satellite instruments: Preparations for assimilation of, respectively, 1) Aeolus L2 HLOS winds, 2.1) MTG-IRS (L1), 2.2 MTG-IRS(L2), 3) IASI-NG, 4) winds from various scatterometers (see also DA3.4), 5) EPS SG-MWS, 6) AWS-MW, 7) MTG-LI, 8) EarthCARE (cloud hydrometeors).	RoAz, FruG, ViPo, MaLi,SuHa, MaSa, ViPo, EoWh, ReEr, JaSa, IsMo,DaSch, JoCa,EoWh,MaMi, GJMa,BjAm,MaDah, ClLa, RoMa, MaBo, PhCh, PaCo, OlCo, RoMa2, DoRa, IbSe, EtVi, 2NN-OBS	Codes and scientific note

DA4.7	Assimilate wind data from recreational hot-air balloon flights in HARMONIE-AROME	CdB	Code and Scientific note
DA4.8	Rain based observations: 1) *Attenuation in telecommunication microwave links due to rain:* Refine the preprocessing to efficiently separate dry and wet attenuation. Study suitable observation operators to assimilate retrieved rain rates (standalone physics package from P. Lopez); 2) *Radar-based rain rate:* explore the same approach for assimialtion of radar-based, measured or analysed rain rates (as done in Morocco).	BeSt, PeSm, PhSc, ZaSa	Codes and Scientific note
DA4.9	New technique for assimilating radar data: 1) Direct assimilation of radar refectivity: In context of OOPS and EnVar connected to DA2.3 with extended control vectors; 2) Radar polarimetric data: assess more European OPERA data for assimilation in Arome-France.	OlCa, MaMa, MaRi	scientific note

t-code deliverables

Task	Responsible	Cycle	Time
DA4.1	1) RoRa, 2-3) PhCh (ST7)	CY48T1 or later	2020-2022
DA4.2	JaSa, AlTr (RT13 / ST5)	CY48T1 or later	2020-2022
DA4.3	JaSa, AlTr (RT13 / ST5)	CY48T1 or later	2022
DA4.4	MaMi, FlMe, PhSc (RT11)	CY48T1 or later	end 2022
DA4.5	KaHi, FlMe (ST4)	CY48T1 or later	end 2022
DA4.6.1-4	1)RoAz, 2-8) PhCh, IsMo (RT5)	CY48T1 or later	end 2022
DA4.7	CbB	CY48T1 or later	end 2022
DA4.8	BeSt, ZaSa (RT6)	CY48T1 or later	end 2022
DA4.9	RoSt, PiBr (RT1), MaMa, AlTr, JaSa (RT13)	CY48T1 or later	end 2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
DA4.1	RoAz	Report about the status of the implementation of All-Sky in CY46	end 2022
DA4.2	SdH,MaIm	Repoort about the impact of GNSS data	
DA4.8	CdB	Technical report	end 2022

ACCORD WorkPackage description : DA5

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
CaGe, MaDi,JaSa	Carlos Geijo (4), Maria Diez(1), Jana Sanchez(1)	AEMET Spain	6
BeSt	Benedikt Strajnar (1)	ARSO Slovenia	1
RoRa	Roger Randriamampiaanina (0.75)	MET Norway	0.75
AlTr, AnBu	Alena Trojakova (0.5), Antonin Bucanek(0.5)	CHMI Czech	1
XiYa, ClPe, KaHi	Xiaohua Yang (1), Claus Pedersen(2), Kasper Hintz(1), MaDah(1)	DMI Denmark	5
ErGr, DaSch	Erik Gregow (2), David Schönach (0.25)	FMI Finland	2.25
SdH, JaBa,SvdV	Siebren de Haan (1.5), Jan Barkmeijer (2), Sibbo van der Veen (3)	KNMI Netherlands	6.5
KrSz, HeKo	Kristof Szanyi (5), Helga Kollathne Toth (2)	OMSZ Hungary	7
NiMe, ThMo	Nicolas Merlet (8), Thibaut Montmerle (0.75)	Météo-France	8.75
MiNe, MaDia	Michal Nestiak(2), Martin Dian (2)	SHMU Slovakia	4
MaLi, ToLa, JeBo	Magnus Lindskog(0.5, qCONDOR), Tomas Landelius (qCONDOR), Jelena Bojarova (qCONDOR)	SMHI Sweden	0.5
FlMe	Florian Meier (1)	ZAMG Austria	1
EoHa	Eoghan Harney (1.5)	MET Eireann	1.5
LeDC	Lesley De Cruz	RMI Belgium	
IvAn,AlLe	Ivar Ansper(0.5), Alina Lerner (1)	ESTEA Estonia	1.5
NiGu	Nils Gustafsson (qCONDOR, HIRLAM consultant)	(not relevant)	

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 tested with a 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. In order to have optimal and effective method, alternative formulations of balance between the control vectors 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 optimisation for RUC/RR setup (hourly/subhourly cycling, short observation window, short cut-off): (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. (See also DA1.1 regarding the use of frequent low resolution observations)	SdH, ErGr, FlMe, MiNe, MaMo, ZaSa, MaDia, KrSz, HeKo, KaHi,MaDi, JaSa,NiGu,ToLa	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. Also see SY 6.3.	XiYa, KaHi, ErGr, ClPe, FlMe NiGu, LeDC, EoHa, JeBo, BeSt, IvAn, SuTo, KrSz, NiMe, ThMo, JaBa, MaLi, NiGu,ToLa,EoHa	Codes and scientific note
DA5.3	Initialisation/spinup: 1) *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; 2) *Field Alignment and Variational Constraints (FA+VC)*: use in the context of data assimilation for NWC, preferably with sub-hourly updates. Consider HDF5 format usage in Field Alignment context; 3) *Incremental analysis update (IAU):* assess in context of hourly and sub-hourly updates; 4) *Nudging (LHN, back and forth technique (see DA1))* (see also DA6.8 in connection with OOPS & EnVar); Explore the use of DDH, ECHKEVO for estimating the observed spinup.	ErGr, ClPe,SvdV, JaBa, SdH,ToLa,JeBo,CaGe, DaSch,SdH,MaDah, IvAn,AlLe	Codes and scientific note

DA5.4	Optimize setup for nowcasting range: optimize design and implementation of a data assimilation system both in terms of algorithm (3D/4D-Var, 3D/4DEnVar in or outside OOPS on overlapped windows) and high density observation (DA1.1 & DA5.1) data suitable for the very short range (0-6h). Consider connection to hectometric scale DA.	AlTr, AnBu, MaLi, ErGr, NiGu,JeBo, **ThMo**	Codes and scientific note
DA5.5	Implement HybridEnVar scheme based on tracking of structures for a very short forecast ranges (0-9h) base on the EPS and alpha control variables.	JeBo	Codes and scientific note

t-code deliverables

Task	**Responsible**	**Cycle**	**Time**
DA5.1	XiYa, ErGr (RT8)	CY48T1	end 2022
DA5.2	XiYa, ErGr (RT8), RoSt	CY48T1	end 2022
DA5.3	CaGe, FlMe, MaLi (RT2)	CY48T1	end 2022
DA5.4	XiYa, ErGr (RT8), RoSt	CY48T1	end 2022
DA4.5	RoSt	CY48T1	end 2022

Non-t-code deliverables

Task	**Responsible**	**Type of deliverable**	**Time**
DA5.1	XiYa, ErGr (RT8)	script and code in CY43h2 or CY46h1	end of 2022
DA5.2	XiYa, ErGr (RT8), RoSt	script and code	end of 2022
DA5.3	CaGe, RoRa	script and code in CY43h2 or CY46h1	end of 2022
DA5.3	EoHa,ErGr,IvAn,AlLe	Scientific note Note from Studies of spin-up	end 2022
DA5.3	MaDa,JeBo	Implemetation of centered IAU and study of performance	end 2022
DA5.5	JeBo	script and code in CY43h2 or CY46h1	end of 2022

ACCORD WorkPackage description : DA6

WP number	Name of WP
DA6	Participation in OOPS
WP main editor	**Roger Randriamampianina, Roel Stappers, Pierre Brousseau, Loik Berre**

Table of participants *(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)*

Participant Abbreviation	Participant	Institute	PersonMonth
RoSt, RoRa	Roel Stappers(4.5), Roger Randriamampianina(0.75)	MET Norway	5.25
PaEs, CaGe	Pau Escriba(1), Carlos Geijo(1)	AEMET Spain	2
DaSM	Daniel Santos-Munoz	DMI Denmark	
EtAr,REK,FaVo,HaPe, PiBr,VaVo,LoBe	Etienne Arbogast (6), Ryad El Khatib (1.5) , Fabrice Voitus (0.75), Harold Petithomme (3), Pierre Brousseau (5), Valérie Vogt (6), Loik Berre (3)	Météo-France	20.25
JeBo, MaLi	Jelena Bojarova (qCONDOR), Magnus Lindskog (2)	SMHI Sweden	2
EoWh	Eoin Whelan	MET Eireann	
JaBa	Jan Barkmeijer(1)	KNMI Netherlands	1
PeSM, BeSt	Peter Smerkol (2), Benedikt Strajnar (1.5)	ARSO Slovenia	3.5
ClFi	Claude Fischer (part of my PM reporting)	Météo-France	

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. An important goal is to pursue the use of OOPS for easening the maintenance of assimilation codes and configurations (through unit tests such as in the DAVAI tool), and the development of advanced configurations such as 3DEnVar with hydrometeors & non hydrostatic variables, 4DEnVar and 4D-Var.
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 does 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.	**REK**, ClFi, RoSt, EtAr, 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, RoSt, ClFi	non t-codes
DA6.4	Develop prototype of full assimilation cycle using OOPS binaries, in the OLIVE/VORTEX (MF) and in the other frameworks. This work will require collaboration first on keeping consistent solutions with unit testing (DA6.3) and exchange of results.	EtAr, PiBr, VaVo, RoSt, BeSt, RoRa, PaEs, CaGe, EoWh, PeSM	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)	**FaVo**, HaPe	t-codes
DA6.7	Digital filter initialization; Incremental Analysis Update (IAU) in OOPS	DaDe	t-codes
DA6.8	EnVar in OOPS: 3DEnVar and 4DEnVar ; improve and optimize scientific options (localization, advection, hybridation), adapt solutions to reduce spin-up effects (ex. IAU, FA, nudging), update with respect to refactored IFS Cycles, assess scalability and optimization. Cloud, hydrometeors and non-hydrostatic variables in control vector and B.	LoBe, EtAr, PiBr, RoSt, RoRa, JeBo,CaGe	t-codes
DA6.9	Other components or approaches : develop large scale error constraint ; allow centred FGAT ; LAM 4DVAR ; LETKF scheme. Find flexible technical solutions for consistent ensemble variational DA/EPS schemes.	RoSt,JeBo,MaLi,PaEs, JaBa	t-codes
DA6.10	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, LoBe, GiFa, EtAr, RoSt, DaSM, HaPe, RoRa	minutes of meetings

t-code deliverables

Task	Responsible (All under TR1, RoSt, PiBr)	Cycle	Time
DA6.1	ECMWF/MF coordination (coordinators)	from CY46T1 to CY48T1	end 2022
DA6.2	EtAr & RoSt	?	?

DA6.5	REK	CY47T1, CY48	completed and integrated in code
DA6.6		CY47T1, CY48	completed and integrated in code
DA6.7	?	?	?
DA6.8	PBr & LBe	from CY46T1 to CY48T1	end 2022
DA6.9	RoSt	after CY48T1	2021 or later

Non-t-code deliverables

Task	Responsible (All under TR1, RoSt, PiBr)	Type of deliverable	Time
DA6.3	EtAr for MF prototypes	updated prototype codes (outside IFS cycles)	?
DA6.10	ClFi, RoSt, RoRa	minutes of meetings, technical notes, presentations for workshops	as relevant

ACCORD WorkPackage description : DA7

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

Table of participants

(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)

Participant Abbreviation	Participant	Institute	PersonMonth
MaDi	Maria Diez (1)	AEMET Spain	1
AlTr	Alena Trojakova (4)	CHMI Czech	4
RoRa	Roger Randriamampianina (0.75)	MET Norway	0.75
BjAm, MaDah,CaPA	Bjarne Amstrup (2), Mats Dahlbom(2), Carlos Peralta Aros(1)	DMI Denmark	5
SiTh	Sigurdur Thorsteinsson (1)	IMO Iceland	1
Heko	Helga Kollathne Toth (0.5)	OMSZ Hungary	0.5
FaSi	Fabiola Silva (1, MIDAS)	IPMA Portugal	1
EoWh,Roda	Eoin Whelan (1.25), Ronan Darcy (1)	MET Eireann	2.25
FrGu, StMa, DoRa	Frank Guillaume (5), Stéphane Martinez (8), Dominique Raspaud (3)	Météo-France	13.5
PaMe, MaRi	Paulo Medeiros (0.5), MaRi, Magnus Lindskog (0.5)	SMHI Sweden	1
MuSe	Mustafa Sert (1)	MGM Turkey	1
DaSch	David Schönach(0.5)	FMI Finland	0.5
AnSt, SuPa	Antonio Stanesic (1), Suzana Panezic (0.75)	DHMZ Croatia	1.75
JaBa,IsMo	Jan Barkmeijer(1), Isabel Monteiro(1)	KNMI Netherlands	2

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	COPE: 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.	MaD, EoWh, MaDah, BjAm, MaRi	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 used 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. Make it available for all available DA schemes. Single (up to date) development stream requested; 4) MTEN to evaluate the impact of observations on the forecast model, assist the exploration 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.	MaDi, MaDah, StMa, DoRa, PaMe, SiTh, FaSi,DaSch, JaBa, IsMo,CaPA, SuPa, AnSt	non-T-codes report
DA7.3	Maintenance and development of ODB software: basic extraction tools from the raw observations to ODB (bator, b2o, ObsConvert). 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 between Meteo France and MET Norway in 2018-2019. Investigate possibility to produce ODB2 formatted feedback output from the Screening and Minimization tasks.	EoWh , BjAm, FrGu, StMa	non-T-codes
DA7.4	SAPP: Assist the local implementation of SAPP for local observations pre-processing with special focus on observations not yet handled by the package.	BjAm, AlTr(1), MuSe(1), RoDa	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), HeKo(0.5), HaBe(1)	non-T-codes, report
DA7.6	Coordination: Communication and coordination of transversal questions (e.g. development of Bator, ObsConvert, and b2o)	AlTr, EoWh, FrGu	

T-code deliverables

Task	Responsible (RT10: PaMe, EoWh, and ST9: PaMe, EoWh, RoRa)	Type of deliverable	Time
DA7.1	EoWh	CY48T1	end 2022

Non-t-code deliverables

Task	Responsible (RT10: PaMe, EoWh, and ST9: PaMe, EoWh, RoRa)	Cycle	Time
DA7.1	EoWh	CY48	end 2022
DA7.2	DoRa	Technical report	end 2022
DA7.2.1	RoRa	script and code	end 2022
DA7.2.2	RoRa	script and play-file	end 2022
DA7.2.3	PaMa	script and code (CI)	end 2022
DA7.2.4	RoRa	CI	end 2022
DA7.3	EoWh	CY48	end 2022
DA7.4	EoWh	Technical note	end 2022
DA7.5	AlTr	Technical note	end 2022
DA7.6	EoWh	Technical report	end 2022

ACCORD WorkPackage description : DA8

WP number	Name of WP
DA8	Basic data assimilation setup
WP main editor	**Roger Randriamampianina, Maria Monteiro**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MSG, GaSt	Malgorzata Szczech-Gajewska (3), Gabriel Stachura (1)	IMGW Poland	4
HaBe, WaKh	Haythem Belgrissi (2), Wafa Khalfaoui (2)	INM Tunisia	4
MaMo	Maria Monteiro (6)	IPMA Portugal	6
ZaSa, FaHd	Zahra Sahlaoui (6), Fatima Hdidou (6)	Maroc Meteo	12
YeCe	Yelis Cengiz (2)	MGM Turkey	2
AnBo,BoTs,KoMl,MiTs	Andrey Bogatchev (1), Boryana Tsenova (1), Konstantin Mladenov (1), Milen Tsankov (1)	NIMH Bulgaria	4
MOAM, GhCh	Mohand Ouali Ait Meziane (3), Ghiles Chemrouk (2)	ONM Algeria	5
AlDe,IdDe	Alex Deckmyn (3), Idir Dehmous (6)	RMI Belgium	9
AlDu	Alina Dumitru (3)	Meteo Romania	3
FrGu	Frank Guillaume (0.5) , Hervé Bénichou (4)	Météo-France	4.5
AlLe, IvAn	Alina Lerner (1), Ivar Ansper (0.5)	ESTEA Estonia	1.5
RoRa	Roger Randriamampianina	MET Norway	0.25
MaLi	Magnus Lindskog	SMHI Sweden	0.5

WP objectives

The objectives of this program are
1. to develop a cross-consortia coordination to help all ACCORD 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 ACCORD 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).	MSG, GaSt, MaMo, ZaSa, FaHd, YeCe, AnBo, BoTs, RiVa, MiTs, MOAM, GhCh, AlDe, IdDe, AlDu, AlLe	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, …).	MSG, GaSt, MaMo, ZaSa, FaHd, YeCe, AnBo, BoTs, RiVa, MiTs, MOAM, GhCh, AlDe, IdDe, AlDu, AlLe	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.	MSG, GaSt, HaBe, WaKh, MaMo, ZaSa, FaHd, YeCe, AnBo, BoTs, RiVa, MiTs, MOAM, GhCh, AlDe, IdDe, AlDu, AlLe	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.	MSG, GaSt, MaMo, ZaSa, FaHd, YeCe, AnBo, BoTs, RiVa, MiTs, MOAM, GhCh, AlDe, IdDe, AlDu, AlLe, IvAn	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.	MSG, GaSt, MaMo,ZaSa, FaHd,AnBo,BoTs,RiVa, MiTs,MOAM, GhCh,AlDe, IdDe,AlDu	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.	MSG, GaSt, WaKh, HaBe, MaMo, ZaSa, FaHd, YeCe, AnBo, BoTs, MOAM, AlDe, IdDe, AlDu, IvAn, AlLe	Code and technical or scientific reports

t-code deliverables

Task	Responsible (ST2: MaMo, RoRa)	Cycle	Time

Non-t-code deliverables

Task	Responsible (ST2: MaMo, RoRa)	Type of deliverable	Time
DA8.1	BoTs, KoMl, MiTs, MSG, GaSt	all countries have access to SYNOP (local in some cases), TEMP, AMDAR and BUOY data	End 2022?
DA8.2	AlDe, HaBe, WaKh, AnBo	Updates on code and technical note	End 2022
DA8.3	MAOM, ZaSa, FaHd, IdDe, MaMo	joint local porting/validation in CY43T2 - SYNOP, TEMP, AMDAR	End 2022
DA8.4	IdDe, ZaSa, MaMo	joint local implementation of OBSMON	End 2022?
DA8.5	MaMo, YeCe, FaHd, ZaSa, MAOM, IdDe (ST2/ST8)	basic scripts KIT (combined oi_main + 3D-var) for testing and validation	End 2022
DA8.6	AlDe, YeCe, IdDe, MaMo	discussion on combined oi_main+3D-Var basic set of scripts	End 2022

ACCORD WorkPackage description : PH1

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

Table of participants *(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)*

Participant Abbreviation	Participant	Institute	PersonMonth
KEL, NaMa,SiSb	Kamal El Karouni (1), Najla Marass (1), Siam Sbii (2)	Maroc Meteo	4
ErBa, YaSe, PaMa, JMP, CeLo, InEt, OlJa, AnHu, LaDe, SaAn, InEt ChLa, SeRi, BeVi, QuLi ViGu, JoGu	Yves Bouteloup (2), Eric Bazile (1.5), Yann Seity (2), Pascal Marquet (3), Jean-Marcel Piriou (3), Cécile Loo (3), Antoine Hubans (2), Laurent Descamps (2), Salomé Antoine (3), Ingrid Etchevers (2): CNRM/GMAP Christine Lac, Sébastien Riette (8), Benoit Vié (2), Quentin Libois (4) : CNRM/GMME Vincent Guidard(1), Jonathan Guth (2): GMGEC	Météo-France	32.5
HaDh, RaBR	Hajer Dhouioui (4), Rahma Ben Romdhane (3)	INM Tunisia	7
MoMo, AbAm, AbBa	Mohamed Mokhtari (2), Abdenour Ambar (2), Abdelhak Bahlouli (1.5)	ONM Algeria	5.5
ChWi	Christoph Wittmann	ZAMG Austria	0.5

WP objectives

Improve the physics parameterizations and diagnostics of the MF NWP configurations, which encompass AROME-France CMC (also previous version of CSC AROME), the other AROME configurations (Overseas, Assistance etc.) and ARPEGE. This activity includes addressing model weaknesses seen in the operational MF suites and partners with the AROEME-CSC, 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 only one physics with SPP perturbations instead of multi-physics for the PEARP, 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: improve wind gust modelling, further improve ICE3/ICE4 especially with respect to forecast of hail, add fog deposition term in ICE3, SOFOG field experiement : sub grid condensation (partial cloud cover) in LIMA.	ErBa, SeRi, **HaDh(2), RaBR(2)**, KEL, ChWi, BoTs	doc, t-code
PH1.2	LIMA microphysics scheme development: use the Meso-NH LIMA developement in AROME	BeVi, ChLa, **HaDh(2), RaBR(1), SaAn, MoMo, AmAb**	test with t-code AROME
PH1.3	Reassess some basics about thermodynamics and turbulence in our models: Lewis number # 1, review stability functions for PBL, consistent moist energy definition and energy transformation cycle.	**PaMa**	doc, papers, t-code
PH1.4	Assess a first (early) version of dust aerosol forecast facility in AROME with linked to an internal Meteo-France project lead by Vincent Guidard	**ViGu**, **YaSe**, **YvBo, JoGu**, AbAm, MoMo, AlMa	doc, t-code
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.). ECRAD will be tested for an operational used in MF's NWP systems for 2023	QuLi, **YvBo**, AbBa, **YaSe**	doc
PH1.6	Model diagnostics: further improve DDH especially LFLEXDIA (also related to PH3.8)	**JMP**, NaMa, **YaSe**, **InEt**	notes, t-code
PH1.7	ARPEGE-specific aspects: use and evaluate the last version of the IFS deep convection scheme and Marocco developments (SiSb), work on the GWD parameterization with comparison with the IFS scheme, try to remove the envelop, test the GMTED input orography, linearized physics with a focus on deep convection in 4D-VAR. addressing the use of only one physics with SPP perturbations instead of multi-physics for the PEARP	**JMP**, **YvBo**, PaMa, **ErBa**, **CeLo**, **AnHu**, FlSu,**SiSb**,**LaDe**	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 ?
PH1.4	ViGu, JoGu	CY46T1_op for demo in e-suite context	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		presentation on SL adjustment	2020
PH1.3	PaMa	short note for WGNE yearly bulletin	2020
PH1.4	ViGu	Presentation of MF internal project "Chemistry Aerosols" to ACCORD partners	late 2021- 2022

ACCORD WorkPackage description : PH2

WP number	Name of WP
PH2	Developments of HARMONIE-AROME physics
WP main editor	**Jeanette Onvlee and Emily Gleeson**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
JaCa, DMP	Javier Calvo (0.5), Daniel Martin Perez (2)	AEMET Spain	2.5
KPN	Kristian Pagh Nielsen (2)	DMI Denmark	2
LaRo	Laura Rontu (2)	FMI Finland	2
WdR, SeCO, NaTh	Wim de Rooij (3.5), Sebastián Contreras Osorio (6), Natalie Theeuwes (2 - WINS50 project)	KNMI Netherlands	11.5
EmGl, EwMA	Ewa McAufield(3), Emily Gleeson (3)	MET Eireann	6
BJE, TeVa, MaKa	Bjorg Jenny Engdahl (4), Marvin Kähnert	MET Norway	4
MeSh, KII	Meto Shapkalijevski (1.75), Karl-Ivar Ivarsson (1)	SMHI Sweden	2.75
GNPe	Gudrun Nina Petersen	IMO Iceland	1

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 and missing low stratus clouds in winter will be studied and where possible improved. Further, the impact of more realistic descriptions for aerosols/ condensation nuclei on the development of clouds and precipitation will be studied and where possible, improved. The behaviour of the new LIMA and ECRAD microphysics and radiation schemes will be assessed and compared to the present ICE3 and IFSradia schemes.

Work will be 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, closely related to PH6). Currently very simple assumptions are made for aerosols that have a significant impact on the clouds, radiation and fog. The aim is to achieve a more realistic description of aerosols 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.

Model weaknesses under stable boundary layer conditions will be studied and potential improvements tested (tasks PH2.6 – PH2.7). In particular, 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 forecasting were found in 2020. A fog working group was set-up and further investigations are on-going - these will be fully validated and consolidated in a Cy46 development branch where the LIMA microphysics scheme and the use of NRT aerosols are also available.

Testing of physics options will move tpwards a more systematic approach in cy46 where each option will be thoroughly evaluated in series for Northern, mid-latitude and Southern domains and the use of additional tools and satellite products for analysis will be more widely employed.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH2.1	**Turbulence and convection**: Continue to explore options for improving the model representation of open cell convection. In this problem microphysics (no formation of cloud ice/snow/graupel for showers warmer than -15°C), shallow convection, (too strong?) turbulent mixing and possibly also evaporation over the sea may play a role. Consider whether the inclusion of stochastic elements in the turbulence parametrization may have a beneficial impact on open cell convection and on the cloud cover behaviour of other cloud types (link with task PH10). Explore the underlying causes of missing low stratus and stratocumulus clouds, especially in strong inversion situations during winter. In addition the impact of increasing horizontal and vertical resolution on the physics, especially on clouds and turbulence, needs to be studied.	JaCa, KIl, WdR, MeSh, MaKa, BJE	t-code, configuration, report
PH2.2	**Microphysics**: Explore the behaviour of LIMA. Explore the behaviour of precipitation at the lateral boundaries (nesting problems). Possible extension and testing of Thompson microphysics scheme in the LIMA framework. Make a detailed assessment of ICE3 in relation to the impact of assumed values of cloud droplet number concentrations (CDNC) as a function of height or stability and vertical velocity, on meteorological phenomena such as fog and other cloud formations, convection and precipitation. Consider ways to parametrize the activation of aerosols in ICE3, and its dependency on e.g. turbulent mixing and vertical velocity, just like the microphysical parameters that determine the droplet size distributions. Cloud water path from satellite observations (e.g. MSG) will be used to verify the best settings for use in the microphysics.	KIl, BJE, DMP, SeCO	t-code, namelist
PH2.3	Complete the work to achieve a **consistent use of particle properties** across microphysics, cloud and radiation schemes: 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 cloud cover from the subgrid fraction and the optical depth of each water species. Connected to task PH6.	EmGl, KIl	t-code, namelist

PH2.4	**Radiation:** Consider how to introduce the ECRAD radiation scheme into Harmonie-Arome. When implemented, assess its performance in 1- and 3D experiments compared to the default IFSradia scheme. Make a more thorough validation of the performance of, and consider the need for further tuning for, the acraneb2 scheme when applied within Harmonie-Arome. Intercompare the hlradia, acraneb2 and ifsradia (and later ECRAD) radiation schemes (connected to PH6), also with a view to their potential use as multiphysics options in HarmonEPS.	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 the impact of (LIMA) cloud microphysics, the use of NRT aerosol and the manner of activation of aerosols and the microphysical parameters that determine the droplet size distributions on the model behaviour for fog. Participate in the SOFOG3D model intercomparison studies, assess whether these case studies can be used to further tune aerosol activation and/or other microphysics aspects.	WdR, EmGl, EwMA, SeCO, DMP	t-code, namelist
PH2.6	**Surface influence on SBL** (see also SU3.10): Study the influence of snow, ice, vegetation and the 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 cells) coupled to the atmospheric model. Also study the impact of the translation from model level/surface to observed levels, and consider alternative near-surface diagnostics formulations. Validate the recently introduced roughness sublayer model (Harman and Finnegan 2007). Study the relation between XRIMAX-problems and other parameters in the surface model.	MS (see surface work packages)	t-code, namelist
PH2.7	A **wind-farm parametrization** (momentum drag) has been developed by KNMI and found to be beneficial. This parametrization should be implemented in the ACCORD NWP system.	NaTh	t-code, namelist, database
PH2.8	**Surface-Radiation Coupling:** HARMONIE-AROME includes separate modules for the radiation physics and the surface physics. These need improvements to ensure optimal surface-radiation coupling. Issues include the spectral band coupling, the proper utilization of the direct and diffuse albedos, and the correct split of the atmospheric direct and diffuse shortwave irradiance components for the specific surface tiles.	KPN	t-code
PH2.9	**Physics evaluation and tools:** Systematic testing of all new physics options settings across a range of domains (Northern mid-latitude, Southern) with a focus on relevant case-studies and the use of satellite products and other tools (e.g. clear sky index, cloud simulator, cloudnet data etc). MUSC idealised cases will also be used when available.	AEMET, Olé, EmGl	reports

t-code deliverables

Task	Responsible	Cycle	Time
PH2.1	WdR, EmGl	43h2.2, 46	
PH2.2	KII	46h	
PH2.3	KPN	46h	
PH2.4	LaRo	46h	
PH2.5	WdR, EmGl	43h2.2, 46h	
PH2.6		46h	
PH2.7	NaTh	CY46h	mid 2022
PH2.8	KPN		
PH2.9		CY46	

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		Namelist	
PH2.7	NaTh	Namelist, wind farm database, manual	
PH2.8	KPN	Source code	
PH2.9		Reports	

ACCORD WorkPackage description : PH3

WP number	Name of WP
PH3	Developments of ALARO physics
WP main editor	**Martina Tudor and Bogdan Bochenek**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PeSm, NePr, MaLi	Peter Smerkol (1), Neva Pristov (1), Matjaž Ličar (3)	ARSO Slovenia	5
RaBr, JaMa, FiSv, DaNe	Radmila Brožkova (8), Jan Mašek (7), Filip Švabik (2.5), David Nemec (6)	CHMI Czech	23.5
MaHr, MaTu	Mario Hrastinski (2), Martina Tudor (2)	DHMZ Croatia	4
BoBo, PiSe	Bogdan Bochenek (4)	IMGW Poland	4
MiVa, LuGe	Michiel Vanginderachter (2) Luc Gerard (4)	RMI Belgium	6
MaDi, MaDe	Martin Dian (2), Maria Derkova (0.5)	SHMU Slovakia	2.5

WP objectives

ALARO is a grid size sensitive physics package. It includes parametrisations of unresolved or partially resolved subgrid processes such as deep and shallow convection, turbulence and gravity wave drag. The parametrisations can be switched off more or less independently. The radiation scheme is goring through minor adaptations to single precission (and alternative HPC architectures to be addressed in SPTR1) while impact of aerosols is considered in PH6, and 3D effects will be done in the scope of PH7. TOUCANS turbulence scheme is being developed with new solutions for numercal solver and a new formulation of mixing length with code re-organization, debugging and cleaning going on. The cloud scheme is further developed escpecially with respect to the shallow convection cloudiness. The work continued on scale aware deep convection scheme that allows partially resolved and partially parametrized deep convection. Microphysics is upgraded with new prognostic condensates such as graupel. ALARO1 is now coupled with SURFEX but this is not used in operational suites due to considerable differences in model forecast, especially regarding the forecast of parameters close to the surface. The team wants to understand where the differences are coming from and if the physics parametrisations need some re-tuning with the new surface representation. There are multiple tasks in different SU packages linked to purely surface representation aspects. Finally, development of ALARO physics package draws subsequent developments in the DDH package. The single column version is addressed in PH4. New diagnostic parameters are addressed in PH5. The machine learning aspects are accounted for in ML1. The work on stochastic version of parametrisations implemented in ALARO is addressed in PH10.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH3.1	Radiation scheme – minor improvements, single precision was prepared, adaptation to new HPC architecture to be addressed in SPTR1, accounting for 3D effects in PH7 and aerosol impact is addressed in PH6	JaMa	doc, t-code
PH3.2.1	Turbulence - TOUCANS scheme – work on the two turbulent energies scheme, numerical aspects including code re-organization, cleaning, debugging	RaBr, JaMa, PeSm	doc, t-code
PH3.2.2	Turbulence - TOUCANS scheme – work on the mixing length computation, several mixing length computation formulations are being tested including prognostic options	MaHr, JaMa, RaBr	doc, t-code
PH3.3	Cloudiness parametrisation utilizes prognostic condensates and water vapour - Cloud scheme, shallow convection cloudiness	JaMa, RaBr	doc, t-code
PH3.4.1	Deep convection scheme - it is made scale aware therefore part of the deep convection can be resolved and part is parametrized. The unresolved components of a deep convective system should still be parametrized, even in 1km resolution. This task is about Non-saturated downdraught	LuGe	doc, t-code
PH3.4.2	Deep convection scheme - it is made scale aware therefore part of the deep convection can be resolved and part is parametrized. The unresolved components of a deep convective system should still be parametrized, even in 1km resolution. This task is about Complementary Subgrid Drafts (CSD)	LuGe	doc, t-code
PH3.5	Microphysics – prognostic graupl is coded and phased in the common code, testing and tuning work is ongoing	BoBo, RaBr, DaNe	doc, t-code
PH3.6	The upper air physics part of the work regarding coupling ALARO1 with SURFEX. The physics package is coupled with a version the SURFEX package and the code is phased in the common cycle. There are substantial differences in the model forecast due to different representation of the land surface used in SURFEX. The work continues on understanding those differences, especially when they lead to deterioration of the model forecast. It is closely connected with several tasks in SU3 and SU6.	MaDi, JaMa, RaBr, FiSv, NePr, MaTu, MaLi	doc, t-code
PH3.7	ALARO-1 validation and maintenance - once a scheme or few of them are upgraded/changed, the whole system is tested and validated for an extended period of time. Cases with substantial forecast errors are analyzed in order to diagnoze what caused those errors. Some options can become obsolete and are cleaned. Studies of specific phenomena, such as fog, severe wind cases, severe convective cases etc. There is a close ling with COM3.1 and MQA work packages.	JaMa, RaBr, MaDe, MaTu, MiVa	report, doc, t-code

PH3.8	Upgrades of DDH tool for ALARO - adaptations of the tool with the more recent developments in ALARO, closely related to DDH developments in PH1 (currently PH1.6)		t-code

t-code deliverables

Task	Responsible	Cycle	Time
PH3.*	JaMa, RaBr	cy49t1	regularly

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ACCORD WorkPackage description : PH4

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
WdR	Wim de Rooij	KNMI Netherlands	1
EoWh, EwMA	Eoin Whelan (0.25), Ewa McAufield (1), Emily Gleeson (1)	MET Eireann	2.25
ErBa, YvBo, JMP	Eric Bazile (1.5), Yves Bouteloup (2), Jean-Marcel Piriou (2)	Météo-France	5.5
MaTu	Martina Tudor (1)	DHMZ Croatia	1

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.
In 2021, a common (between the 3 CSC) MUSC version based on cy46t1 should have been created and validated at least for some cases. A continuation effort shoud be done in 2022 to increase the number of available "ideal" cases in order to have a diversity of meteorological siutation to evaluate, compare all the parametrizations available accross the CSC and ARPEGE. Therefore a training and/or working days can be organized may be every two years or for a new MUSC version based on a new cycle.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH4.1	Establish, maintain and upgrade “common MUSC” system	DaDe, **JMP**, MaTu, **ErBa, YvBo, EoWh**	
PH4.2	Create and add (idealized) test cases	all	
PH4.3	MUSC training and working days	MaTu,WdR, EoWh	
PH4.4	MUSC used for testing "the possible refactoring" of aplar and apl_arome linked with PH9.8	**ErBa, YvBo**	

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	

ACCORD WorkPackage description : PH5

WP number	Name of WP
PH5	Model Output Postprocessing Parameters
WP main editor	**Claude Fischer, Jeanette Onvlee, Eric Bazile and Martina Tudor**

Table of participants

This list of participants contains both names recently provided by the LTMs, and names indicated in 2020 (and kept). The list will be reviewed according to the outcome of the PH5 inquiry (2021-2022 action), by PM+CSC Leaders+CNA. Not all names have an associated manpower commitment for now.

Participant Abbreviation	Participant	Institute	PersonMonth
NePr	Neva Pristov	ARSO Slovenia	0.5
OlJa, InEt, JMP	Olivier Jaron (5), Ingrid Etchevers (2), Jean-Marcel Piriou (2)	Météo-France	9
AnSi	Andre Simon	SHMU Slovakia	4
MaDe	Maria Derkova	SHMU Slovakia	0.25
ChWi, ClWa	Christoph Wittmann (1), Clemens Wastl (1 for PH5.2 & PH5.3)	ZAMG Austria	2
MaTu	Martina Tudor (PH5.3)	DHMZ Croatia	1
MaKo	Marcin Kolonko (1)	IMGW Poland	1
KaEK, NaMa	Kamal El Karouni, Najla Marass	Maroc Meteo	1
BoTs, KoMl, MiTs	Boryana Tsenova (1), Konstantin Mladenov (1), Milen Tsankov (1)	NIMH Bulgaria	3
AhMe, IvAn	Ahto Mets (0,5), Ivar Ansper (0.5)	ESTEA Estonia	1
AlCr, AlDu, MiPi, SiTa	Alexandra Craciun (1pm - PH5.3), Alina Dumitru (1pm - PH5.3), Mirela Pietrisi (1pm - PH5.3), Simona Tascu (1pm - PH5.3	Meteo Romania	4
WaCh	Walid Chikhi	ONM Algeria	5

WP objectives

There is an increasing need for new postprocessing parameters out of the NWP systems for many applications such as aeronautics, green energy sector, automatic forecasting and for various end-users. This need is reflected in the ongoing work of many NMSs in ACCORD.

In this WP, we address the work on the model output, as produced mostly from the executables available from compilation (ie MASTERODB). The activities on postprocessing are coordinated within this package in order to avoid possible duplication of work. In 2021, an inquiry was launched in order to update the list of diagnostic and output fields planned or under consideration by the local teams. The goal then also was to understand (1) whether these model outputs could/should be considered for computation during the model runtime (if they require specific model fields) or (2) whether they could/should be part of an offline, downstream post-processing.
Only the first case clearly belongs to the ACCORD RWP matters (common codes).

Specific postprocessing related to ensemble forecasts is addressed in E packages, the same for DA etc.
The aim of the WP PH5 is to coordinate the work done on the implementation of the selected parameters into the common code for all three CSCs, and to implement, tune and validate these parameters. The new postprocessing parameters need to be validated (related to MQA) and for that new data types might be needed (DA3-DA4).

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH5.1	Preparation of an inquiry for all ACCORD local teams: try to get a thorough feedback on plans about new model diagnostic output fields. Draft the questionary, send it out and collect/process the results. The questionary might be updated every 2-3 years. Preparation of a work plan for implementation of selected postprocessing parameters into the code	PM, CSC-Leaders, CNA	questionary & work plan
PH5.2	Development and implementation of ***new*** model output postprocessing/diagnostic fields	**OlJa**, **JMP**, **InEt**, ChWi, ClWa, AnSi	t-code, reports
PH5.3	Improvements, tuning and validation of ***existing*** model output postprocessing/diagnostic fields, related to MQA2. As one concrete example, MF plan to regurlarly monitor the performance of the lightning diagnostic implemented in ARPEGE and AROME, and operational since 2020. Get feedback from users.	all local teams invovled in PH5 & MQA2	t-code, reports
PH5.4	Adapting post processing field computations from one CSC to another. For instance, differences in the definition of prognostic variables between CSCs may require an adaptation. One concrete example was the adaptation of the lightning diagnostic from ARPEGE/AROME to ALARO, expected to be completed by end 2021.	**InEt, OlJa, JMP**	t-code, reports

t-code deliverables

Task	Responsible	Cycle	Time
PH5.2		CY49T1 or later	2022+
PH5.3		CY49T1 or later	2022+
PH5.4		CY49T1 or later	2022+

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
PH5.1	PM + CSC Leaders + CNA	- questionary - work plan	- end of 2021 - end of 2021/beginning of 2022
PH5.2		reports, notes	2022
PH5.3		reports, notes	2022
PH5.4	CSC-Leaders	reports, notes	2022

ACCORD WorkPackage description : PH6

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

Table of participants 2021

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth**
DMP	Daniel Martin Perez (3)	AEMET Spain	3
EmGl	Emily Gleeson (2)	MET Eireann	2
JaMa	Ján Mašek (1.5)	CHMI Czech	1.5
KII	Karl-Ivar Ivarsson	SMHI Sweden	
KPN	Kristian Pagh Nielsen	DMI Denmark	1
LaRo	Laura Rontu	FMI Finland	4
PiSe	Piotr Sekula	IMGW Poland	2
MoMo, AbAm	Mohamed Mokhtari, Abdenour Ambar	ONM Algeria	2
ViGu, JoGu	Vincent Guidard (0.25), Jonathan Guth (0.25)	Météo-France	0.5
AnSl	Ana Šljivić (2), Martina Tudor (0.25)	DHMZ Croatia	2.25

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 ACCORD system.

DETAILED DESCRIPTION: Basic decision is to use CAMS n.r.t. aerosol mass mixing ratios (MMRs), and to provide infrastructure enabling its exploitation in all ACCORD CMCs. The design should be general enough in order to make possible future use of alternative aerosol data (e.g. from MOCAGE). Usage of CAMS aerosol MMRs via traditional monthly climate files will be ensured, as well as backward compatibility using aerosol optical depth (AOD550) climatology as input. PH6 aims at: 1) Preparation and transfer of aerosol input to the forecast model 2) Ensuring consistent code structures, interfaces and namelist definitions in the forecast model, available for specific radiation and cloud microphysics parametrizations 3) Providing utilities for use in data transfer, namelist generation and testing.

PH6.1. IMPLEMENTING DATA FLOW OF NEAR REAL TIME (n.r.t.) AND CLIMATOLOGICAL AEROSOLS.
n.r.t. aerosol MMR fields from CAMS are extracted and accommodated in the lateral boundary files using gl software that is available for the whole consortium. From the initial / coupling files the n.r.t. MMRs are read as standard GFL fields. This enables their advection and lateral coupling, as well as easy propagation across the model code, and possibly also into the output files. n.r.t. aerosol MMRs are passed to the level of MF_PHYS, where they continue to APL_AROME and APLPAR for further processing for radiation and cloud microphysics. **The data flow of CAMS and MOCAGE n.r.t. aerosol will be checked, tested and updated as needed.**
Vertically integrated climatology of CAMS aerosol MMRs is preprocessed and accommodated in monthly climate files. These 2D fields enter model via initial file, and after reconstructing 3D aerosol MMRs (assuming idealized vertical profiles) they are 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. **The suggested data flow of climatological aerosol from climate files to the forecast model will be analysed, updated as needed and documented. Possibility to convert 2D MMRs to 3D at setup level will be considered. The possibility to replace external preprocessing of MMRs with the use of netcdf tools from ECRAD will be studied.**
Aerosol inherent optical properties (IOPs) for 11 CAMS species are preprocessed and accommodated in an ASCII file (RADAIOP). Its contents are passed to forecast model using a setup routine. **The possibility to replace external preprocessing of IOPs with the use of netcdf tools from ECRAD will be studied.**

PH6.2. AEROSOL CODE CONVERGENCE IN CLIMATE GENERATION AND FORECAST MODEL
Aerosol MMRs or Tegen AOD550 data arriving at MF_PHYS level are passed from there further to APL_AROME and APLPAR at every time step. Aerosol IOPs are set up once for each forecast run and enter via modules. Use of aerosol data in radiation and cloud microphysics parametrizations is controlled by namelist variables. New and updated routines have been introduced for preparation of aerosol-related input variables in APL_AROME. **Updates suggested within cy43 will be evaluated, aiming at consistent and optimal design of interfaces, namelist definitions, module and variable usage in cy46. Duality of aerosol MMRs versus (Tegen) AOD550 input will be addressed. A document on aerosol convergence will be prepared, containing the findings, solutions and guidelines. Note that PH6.2 is strongly connected to PH9.4.**

PH6.3. PREPARATION OF REAL-TIME AEROSOL OPTICAL PROPERTIES FOR THE RADIATION SCHEMES
Subroutines converting CAMS aerosol MMRs and IOPs to optical properties of aerosol mixture (layer optical depth, single scattering albedo and asymmetry factor) have been created. Relative humidity, that affects optical properties of hydrophilic aerosols, is taken into account. Calculations

Descriptions of tasks 2022

Task	**Description**	**Participant abbrev.**	**Type of deliverable**
PH6.1	IMPLEMENTING DATA FLOW OF NEAR REAL TIME (n.r.t.) AND CLIMATOLOGICAL AEROSOLS.		t-code
PH6.2	AEROSOL CODE CONVERGENCE IN CLIMATE GENERATION AND FORECAST MODEL		report
PH6.3	PREPARATION OF REAL-TIME AEROSOL OPTICAL PROPERTIES FOR THE RADIATION SCHEMES	JaMa, AnSl	t-code
PH6.4	INTERFACING NEAR REAL TIME AEROSOLS WITH CLOUD MICROPHYSICS		t-code

PH6.5	CLOUD - AEROSOL - RADIATION INTERACTIONS		t-code
PH6.6	VALIDATION AND TESTING	all participants of PH6	report

t-code deliverables 2022

Task/Responsible	Deliverable	Cycle 46t1	Time 2022
PH6.1	1. GFL dataflow for the set of CAMS aerosol MMRs from init/coupling files to the level of MF_PHYS. 2. Updated dataflow for the set of climatological aerosol MMRs from the monthly climate files to the level of MF_PHYS.		
PH6.3	3. Subroutines for converting the set of CAMS aerosol MMRs+IOPs to optical properties of the aerosol mixture (layer optical depth, single scattering albedo and asymmetry factor). 4. Interfacing ACRANEB2 with the externalized optical properties of aerosol mixture. Possible introduction of these AOPs to IFSRADIA and later possible modifications of ECRAD. 8. Introduction of aerosol-capable HLRADIA parametrizations to the common code (not intended for operational use).	JaMa	
PH6.4	5. Subroutine for converting the set of CAMS aerosol MMRs to CCN and IFC concentration numbers used as input for the cloud microphysics schemes 6. Subroutine to convert LIMA tendencies into aerosols MMRs tendencies.		
PH6.5	7. Subroutine containing existing and suggested new parametrizations of cloud particle effective size for input to radiative transfer calculations.		

Non-t-code deliverables 2022

Task	Responsible	Type of deliverable	Time

ACCORD WorkPackage description : PH7

WP number	Name of WP
PH7	Develop approaches for 3D physics
WP main editor	**Jeanette Onvlee, Eric Bazile and Martina Tudor**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
RaHo, REK, ErBa, PhD	Rachel Honnert (6), Ryad El Khatib (0.25) , PhD student (4 months)	Météo-France	10.25
DiRi	Didier Ricard (CNRM/GMME)	Météo-France	2
KPN	Kristian Pagh Nielsen	DMI Denmark	1
MaTu	Martina Tudor	DHMZ Croatia	0.5

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. The horizontal effects are accounted for separately using additional schemes (cuch as SLHD with related task in HR1). 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. Also, radiaiton is currently computed in vertical colums while the direct shortwave radiation actually follows the path of the Sun.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH7.1	test the horizontal gradients in 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, **RaHo**	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	**RaHo**, ErBa,	t-code, documentation
PH7.4	Investigate technical options for 3D physics in ALARO	MaTu	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	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	

ACCORD WorkPackage description : PH9

WP number	Name of WP
PH9	Consistency and convergence of the CSC physics
WP main editor	**Claude Fischer, Jeanette Onvlee, Eric Bazile and Martina Tudor**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
FaVo, SyMa, GMAP/PROC, ClFi, ErBa, YvBo, YaSe	Fabrice Voitus (2.5), Sylvie Malardel (0.5), other colleagues from MF team, Claude Fischer, Eric Bazile (2), Yves Bouteloup (2), Yan Seity (1)	Météo-France	8
DaDe	Daan Degrauwe (1), Piet Termonia	RMI Belgium	1
LaRo	Laura Rontu	FMI Finland	1
JaMa	Jan Masek	CHMI Czech	
BoBo	Bogdan Bochenek	IMGW Poland	1
MaTu	Martina Tudor	DHMZ Croatia	1
JeOn	Jeanette Onvlee	KNMI Netherlands	1

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, one would aim for interoperability that enables the exchange of individual parameterizations between the CSC'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 as well as the assumptions made in developing those parametrisations. An inventory of remaining scientific and technical blocking points for a further convergence between the CSC's is needed as well.

After the selection process for the ACCORD Area Leaders was completed and no Physics Area Leader was found, the Assembly appointed a dedicated WG wih the aim of bringing the analysis of interoperability as far as feasible. The WG will prepare a roadmap proposal for the end of 2022. This WP PH9 takes into account the current status of brainstorming, analysis and discussions lead by the WG.

The long term vision currently envisaged by the WG is that the physics interface codes should guarantee a high level of interchangeability of individual parametrizations (and their codes), with an enhanced scientific documentation and an easier maintenance. In this respect, one main shortcoming in our present codes is the complexity of the intermediate physics interface code, known as the APLPAR/APL_AROME routines. Thus, a concrete long term goal which is currently being analyzed by the WG, is to refactor this code level in order to eventually reach one single code enabling various individual physics combinations (based on the current CSC options but not only). The analysis of the required intermediate steps for this refactoring and liaison with both physics and programming experts will continue in 2022, until drafting the roadmap proposal is completed. It is worth noticing that the concrete planning is likely to involve a few specific steps that will be shared (or are very similar) to needs recently identified for code adaptation (this is a link with **SPTR1**).

Regarding the physics/dynamics interface, one scientific issue is that local sources and sinks of total water in the physics are automaticaly compensated by local sinks/sources of dry air. The reason is that ***total mass*** conservation is the law imposed by the continuity equation of the model even if the physics parametrisations create sources/sinks of total
water. Thus, the model does not conserve dry air.

Physics parametrisations are usually solved either at constant pressure or at constant volume. In the non-hydrostatic model, one has to account for the changes in pressure that happen due to physics parametrisations consistently with the choices made in the physics dynamics interface and the dynamics.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
PH9.1	Collecting information and drafting recommendations needed when changing horizontal/vertical/temporal resolution. In this task, both individual parametrizations or CSC physics packages will be considered. The goals are to: - describe for what scales and meteorological key aspects a parametrization, or a package of parametrizations, has been designed, developed and tuned. A "lower" bound will be given when relevant in terms of horizontal or vertical coarse-grid resolution, or length of time step - provide any relevant additional detail on tuning or choices of options in dynamics or physics - describe the assumed limitations (in link with scientific assumptions) - describe known limitations from past experimental evidence (or past O2R documentation) This task focusses on the [10km - 1km] grid spacing range, and leaves similar kind of investigation and recommendation for the hectometric scales to the dedicated WP HR1 (see task HR1.12 therein)	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	Evaluate the impact of changing the thermodynamics variable for specific parametrisations or diagnostic computaitons. The idea would be to build on the proposal by Pascal Marquet. Applications could be on specific diagnostic fields (eg. like the example of the computaiton of the PBL height), turbulence (changing the Theta variable has a consequence on the equations, in any scheme), impact of having the Lewis number # 1.	GMAP/PROC, DaDe	Documentation, code in t-cycle (long-term)
PH9.4	Ensure consistency across CSCs between treatment of aerosols, clouds and radiation (related to PH6.2)	LaRo, JaMa, MaTu	Documentation
PH9.5	Conservation of dry mass (in the past aka deltam=1 option) - investigate the question of consistency of the conservation of mass in the IFS/ACCORD models. There is an inconsistency between the continuity equation (total mass is conserved) and the physical principle that dry air mass should be conserved. This leads to the implicit assumption that, in physics parametrizations, changes of dry air mass compensate for changes in water mass (eg due to changes of mass of water species or atmospheric components). The idea in this task is to start evalute the impact of these assumptions in an idealized framework. In addition, one possible solution (add sources/sinks of total water in the total mass continuity equation) is already coded and will be further discussed with ECMWF. Another solution, more demanding in terms of coding, will be evaluated in a second stage (based on a proposal by Lauritzen etal. 2018, and recently discussed in a paper by Peng etal. 2000). It is believed that this issue will be more important for climate, atmospheric composition and aerosol sensitive applications.	FaVo, SyMa, student?	Documentation, code in t-cycle (long-term)
PH9.6	Projection of physics tendencies on NH variables - in the case of diabatic heating at constant volume, if the parametrisation does not take into account the work of the internal pressure forces, both prognostic equations have to be updated by the diabatic term and the work of the internal pressure force is explicitly computed by the dynamics.	FaVo, SyMa, student?	Documentation
PH9.7	WG for interoperability: - analysis of the intermediate steps required for a progressive implementation of the long term goal - discussions with experts from physics and programming - ensure information to the CSC teams - drafting recommendations and eventually a roadmap	JeOn, MaTu, DaDe, SyMa, PiTe, ClFi	Documentation (roadmap proposal)
PH9.8	Start realizing specific steps from PH9.7, in order to implement the long term vision, after discussing with the CSC teams. These initial steps are likely to concern the simplification of the APLPAR/APL_AROME code level, an effort that will facilitate the scientific analysis and the investigation of novel programming choices (object-oriented coding for instance). The simplification will profit to the SPTR1 WP as well (simpler routines will ease the exploration of HPC porting strategies). Quite concretely, these steps could include efforts for cleaning the APL* codes, and splitting them first per CSC, in order to remove obsolete options and to identify cleanly delimited parameterization blocks.	**ErBa, YvBo**, **YaSe**	code in t-cycle

t-code deliverables			
Task	**Responsible**	**Cycle**	**Time**
PH9.3	GMAP/PROC	?	(depending on outcome of theoretical research)

Non-t-code deliverables			
Task	**Responsible**	**Type of deliverable**	**Time**
PH9.1	MaTu	report	Mid 2022
PH9.2	DaDe	report	Mid 2022
PH9.3		report	2022-2024
PH9.4	LaRo	report	First version spring 2021
PH9.7	ClFi	report	End 2022

ACCORD WorkPackage description : PH10

WP number	Name of WP
PH10	Fully stochastic physics parametrizations
WP main editor	**Eric Bazile and Martina Tudor**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MeSh	Metodija Shapkalijevski	SMHI Sweden	0.5
FrBt, AxFl	François Bouttier (1), Axelle Fleury (4.5)	Météo-France	5.5
MiVa, JoVa	Michiel Vanginderachter, Joris Van den Bergh	RMI Belgium	

WP objectives

Currently we have a few approaches for upper-air stochastic parameterizations in the ACCORD 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	reports
PH10.2	Train ML algorithms on hindcasts to reproduce systematic model errors. Report on the outcomes of the development of the VVUQ techniques using URANIE within the ESCAPE-II project	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

ACCORD WorkPackage description : SU1

WP number	Name of WP
SU1	Algorithms for surface assimilation
WP leaders	**Patrick Samuelsson, Rafiq Hamdi, Benedikt Strajnar, Ekaterina Kourzeneva, Camille Birman**

Table of participants *(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)*

Participant Abbreviation	Participant	Institute	PersonMonth
EkKo, ErGr	Ekaterina Kourzeneva (3.0), Erik Gregow(0.5)	FMI Finland	3.5
FaHd, ZaSa	Fatima Hdidou, Zahra Sahlaoui	Maroc Meteo	0
ÅsBa, MaHo, TrAs, YuBa, JoBl	Åsmund Bakketun (H2O*), Mariken Homleid (1, 1 MetCoOp*, AROME-Arctic*), Trygve Aspelien (1, H2O*), Yurii Batrak (Alterness), Jostein Blyverket (H2O)	MET Norway	2
CaBi	Camille Birman (8)	Météo-France	6.75
RaHa, IdDe	Rafiq Hamdi (1.0), Idir Dehmous (3)	RMI Belgium	4
ViTa	Viktor Tarjani	SHMU Slovakia	2
PaSa, JeBo, MaLi, ToLa	Patrick Samuelsson (1.5), Jelena Bojarova (2 ext), Magnus Lindskog (MetCoOp*), Tomas Landelius (ext*)	SMHI Sweden	1.5
HeKo	Helga Kollathne Toth	OMSZ Hungary	2.5
MaLa	MaLa Matjaž Ličar (3)	ARSO Slovenia	3

WP objectives

The main objective is to introduce and assess more advanced data assimilation algorithms for the surface assimilation framework.

Development of existing and new algorithms will continue in SODA. These algorithms are based principally on various flavours of Optimum Interpolation (OI) and 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 (SU2). Currently in SODA algorithms and tiles are not separated but the plan is to perform such a separation.

Two spatialisation tools are developed and used, CANARI (all CSCs) and TITAN/gridPP (HARMONIE-AROME CSC). The plan is that CSCs will continue these developments.

Continue discussions and plans with Data Assimilation Area for the road towards a coupled atmosphere-surface assimilation system.

CSC details:
HARMONIE-AROME: Short term plans (2022): Continue development of SEKF and TITAN/gridPP in combination with multi-layer ISBA physics and, in parallell, explore and develop EnKF algorithms. Continue the development of assimilation of sea-ice surface temperature in SICE. Continue to use and explore crowdsourcing data (e.g. Netatmo) via the TITAN/gridPP framework. Medium to long term plans (2022-2023): Includes investigation of evolving B, checking of time scales and length of assim window + potential assimilation enhancements. Include assimilation of FLake variables.
ALARO: Information on precipitation and downward radiation fluxes provided by surface networks and satellite remote sensing will be used in the algorithms in order to get improved surface analyses.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU1.1	Develop/assess SEKF for soil, snow and vegetation using SYNOP data in combination with Diffusion Soil, Explicit Snow and MEB schemes in SURFEXv8.1		see subtasks
SU1.1.1	Continue to 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 test-operational system based on SEKF for soil, snow and vegetation.	EkKo, MaLi, JeBo, PaSa, MaHo, TrAs, ÅsBa	report
SU1.1.4	Validation of SEKF surface assimilation with SYNOP observations and operational upgrades.	ViTa, HeKo, MaLa	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	RaHa	t-code, configuration
SU1.6	Surface analysis strategy for AROME-MAROC	ZaSa, FaHd	configuration report
SU1.7	Continue the development of pySurfex including TITAN and gridPP and coupling to SODA. Solve the aerosol-update now done in CANARI.	TrAs, ÅsBa, ErGr	t-code, code, report
SU1.8	Continue work on EnKF and assimilation of raw radiances (e.g. soil moisture, temperature and snow (smos), vegetation optical depth). 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 multi-patches approach. In the long term this will lead towards consistent surface and upper-air surface perturbations.	ToLa, JeBo, EkKo, JoBl	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 DA2.6.	PaSa, RoRa, DaSa, 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 2022
SU1.1.2	PaSa	SURFEX code contributions	End 2022
SU1.2	EkKo, MaHo	SURFEX code contributions, cy46+	End 2022
SU1.3	EkKo	SURFEX code contributions, cy46+	Mid 2022
SU1.4	YuBa	SURFEX code contributions, cy46+	End 2022
SU1.5	RaHa	SURFEX code contributions	End 2022
SU1.7	TrAs	cy4x contribution, SURFEX code contributions	End 2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU1.1.3	PaSa	Evaluation report	End 2022
SU1.1.4	ViTa	Evaluation report	End 2022
SU1.3	CaBi	Evaluation report	End 2022
SU1.4	YuBa	HARMONIE script system	End 2022
SU1.5	RaHa	Evaluation report	End 2022
SU1.6	ZaSa	Evaluation report	End 2022
SU1.7	TrAs	Harmonie script system, Evaluation report	End 2022

ACCORD WorkPackage description : SU2

WP number	Name of WP
SU2	Use of observations in surface assimilation
WP leaders	**Patrick Samuelsson, Stefan Schneider, Benedikt Strajnar, Ekaterina Kourzeneva, Camille Birman**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth or External project
EkKo	Ekaterina Kourzeneva	FMI Finland	1
BiCh	Bin Cheng (UC INTAROS*)	FMI Finland	1
MaHo	Mariken Homleid (MetCoOp*, AROME-Arctic*)	MET Norway	0
YuBa	Yurii Batrak (ext*)	MET Norway	0
TrAs	Trygve Aspelien (0.5, H2O*)	MET Norway	0.5
CaBi, NaFo	Camille Birman (2), Nadia Fourrié (1)	Météo-France	3
PaSa	Patrick Samuelsson	SMHI Sweden	1.5
HeKo	Helga Toth Kollathne	OMSZ Hungary	1
BaSz	Balázs Szintai	OMSZ Hungary	4
StSc	Stefan Schneider	ZAMG Austria	1.5
SaOs	Sandro Oswald	ZAMG Austria	3
FlMe	Florian Meier	ZAMG Austria	0.5

WP objectives

The main objective is to explore and develop use of non-traditional surface-related observations.

New observations will be introduced from satellite products/radiances representing surface temperature (land/sea-ice/lake), Leaf-Area Index (LAI), Vegetation Optical Depth (VOD), 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
SU2.3	Examine available satellite sea-ice extent products.	YuBa, BiCh	report, code
SU2.4	Explore the possibility to use SIMBA buoys for assimilation of sea-ice conditions (in research mode).	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	report
SU2.5.4	[satellite derived skin temperature] - [2D OI in CANARI] - [AROME]	CaBi, NaFo	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].		
SU2.7.1	[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	[Sentinal-3-based LAI] - [sEKF] - [8.1] daily updated LAI for AROME	BaSz, HeKo, StSc, SaOs	report, 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].		

SU 2.10	Examine available albedo products for use in surface data assimilation. The description of the sub-tasks contains the following information: [product] - [assimilation method] - [SURFEX version].		
SU 2.10.1	[Landsat 7] - [replacing of model values] -[8.1]	SaOs	report

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU2.3	YuBa	report, script changes	End 2023
SU2.4	BiCh	report	End 2022
SU2.5.1	RaHa	tbd	2022/2023
SU2.5.4	CaBi	publication	End 2022
SU2.6	TrAs	report	End 2022
SU2.8.1	BaSz	report	End 2022
SU2.8.2	StSc	publication	End 2022

ACCORD WorkPackage description : SU3

WP number	Name of WP
SU3	SURFEX: validation of existing options for NWP
WP leaders	**Patrick Samuelsson, Samuel Viana, Bogdan Bochenek, Adrien Napoly, Ekaterina Kourzeneva**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
SaVi	Samuel Viana	AEMET Spain	1.5
OlSa	Olli Saranko (HERCULES*)	FMI Finland	1
JodVr	John de Vries	KNMI Netherlands	0
MaHo, TrAs, ÅsBa	Mariken Homleid (1, 1 MetCoOp*, 1 AROME-Arctic*), Trygve Aspelien (xx, H2O*), Åsmund Bakketun (H2O*)	MET Norway	2
EmGl	Emily Gleeson	MET Eireann	1.5
PaLM, AaBo, MaMi	Patrick Le Moigne (2), Aaron Boone (2), Marie Minvielle (1): CNRM/GMME	Météo-France	5
YaSe, ErWa, AdNa	Yann Seity (1), Eric Wattrelot (4), Adrien Napoly (7): CNRM/GMAP	Météo-France	12
RaHa, JaDp, FrDu, StCa, NiGh	Rafiq Hamdi (3), Jan De Pue (xx), François Duchene (xx), Steven Caluwaerts (xx), Nicolas Ghilain	RMI Belgium	3
PaSa, JeBo, KIIv	Patrick Samuelsson (1.5), Jelena Bojarova (xx), Karl-Ivar Ivarsson (0.75)	SMHI Sweden	2.25
StSc, FlWe, ChWi, FlMe, NaAw, ClWa	Stefan Schneider (2.5), Florian Weidle, Christoph Wittmann (1), Florian Meier, Nauman Awan, Clemens Wastl	ZAMG Austria	3.5
MaDi	Martin Dian	SHMU Slovakia	
JaMa	Ján Mašek	CHMI Czech	0
EkKo	Ekaterina Kourzeneva	FMI Finland	1

WP objectives

The main objective is to explore and validate available SURFEX physics components.

With respect to the nature tile more physically based surface components are in principle available from SURFEXv8, i.e. including e.g. Diffusion Soil scheme (DIF) and Explicit Snow scheme (ES), although the SURFEX team only recommend use of these componenets from SURFEXv8.1 and onwards. Please note, Multi-Energy Balance (MEB) is only available from v8.1. The DIF scheme also offers a number of hydrological options. Assessing the potential of the new options should be done in tight connection to the corresponding assimilation methods (SU1). In addition, prognostic LAI could provide better surface resistance and transpiration control and opens up for assimilation of LAI products (SU2).

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 necesserally 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. Thus, 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 ACCORD 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 effect of new ECUME flux formulations.

CSC details:
AROME: 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.
HARMONIE-AROME: Plan is to release cy46h with DIF, ES and MEB active as default settings.
ALARO: Scientifically consistent transition of ALARO-1 from directly called 2-level ISBA to SURFEX should be finalized, addressing also observed fibrillation issues. Goal is to have the necessary changes entering t-cycle (NWP SURFEX commit).

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SU3.1	Test and validate the behaviour of individual components, as well as the full combination, of DIF, ES, (MEB) in cy43h/SFXv8.1 and cy43t/SFXv8.0. 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, KII, JodVr, TrAs, PaLM, AaBo, MaMi, RaHa, JaDp,FrDu,StCa, FlWe, ChWi, FlMe, EkKo, AdNa	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, AdNa, EkKo	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, AdNa	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, AdNa	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, NaAw, AdNa, YaSe	report, configuration
SU3.4	Test DIF in the framework of (S)EKF assimilation in SURFEX 8.1, combined with AROME CY40/CY43. Validation with SYNOP stations.	StSc, ChWi, AdNa	report
SU3.5	Further improve AROME/CMO coupling for tropical cyclone prediction	ErWa	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, KIlv, (KrPN, EmGl)	report, configuation
SU3.8	Evaluation of ALARO-1 screen level interpolation in SURFEX (N2M=3 option in cy43h)	ChWi	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 PH2.6.	MaHo, ChWi, ClWa, EkKo	
SU3.12	Evaluate prognostic LAI (A-gs) for HARMONIE-AROME, AROME and ALARO	JaDp, NiGh, StSc	
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 2022
SU3.2	JodVr	SURFEX code contributions	End of 2022
SU3.8	JaMa	SURFEX code contributions	Autumn 2022
SU3.9	MaDi, JaMa	SURFEX code contributions	Autumn 2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU3.1.1	SaVi	report	End 2022
SU3.2	JodVr	script changes, namelist changes	End 2022
SU3.3	OlSa	report, namelist changes	End 2022
SU3.4	StSc	report	End 2022
SU3.5	**ErWa**	report	
SU3.7	SaVi	report, namelist changes	End 2022
SU3.9	MaDi	report	End 2022

ACCORD WorkPackage description : SU4

WP number	Name of WP
SU4	SURFEX: development of model components
WP leaders	**Patrick Samuelsson, Bogdan Bochenek, Ekaterina Kourzeneva, Patrick Le Moigne**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
KPNi	Kristian Pagh Nielsen	DMI Denmark	1
LaRo	Laura Rontu (xx)	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	2
PaSa, MeSh	Patrick Samuelsson (1.5), Metodija Shapkalijevski (1.0)	SMHI Sweden	2.5
RaHa,JaDP	Rafiq Hamdi (1), Jan De Pue (0.5)	RMI Belgium	1.5
SaVi	Samuel Viana	AEMET Spain	3.5
JodVr	John de Vries	KNMI Netherlands	0
EkKo	Ekaterina Kurzeneva	FMI Finland	1

WP objectives

Main objective is further development or new development of 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 alternatives 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	t-code
SU4.5	Further evaluation and development of MEB which can include low-vegetation application, separate soil column under snow/non-snow, snow albedo in forest, effect of intercepted snow on albedo.	PaSa, AaBo	t-code
SU4.7	Evaluation of the phenology in ISBA-Ags.	RaHa, JaDP	report
SU4.8	Implementation of roughness sublayer. Includes diagnostic and stability dependent roughness length, modified exchange coefficients and modified near-surface diagnostics.	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, EkKo	
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
SU4.12	Implementation of 1D sea model GOTM into SURFEX	YuBa	t-code

t-code deliverables

Task	Responsible	Cycle	Time
SU4.1	BoPa	SURFEX code contributions	End 2022
SU4.2	YuBa	SURFEX code contributions	End of 2022
SU4.3	LaRo	SURFEX code contributions	End of 2022
SU4.5	PaSa	SURFEX code contributions	End of 2022
SU4.7	RaHa	Report	End of 2022

SU4.8	MeSh	SURFEX code contributions	End 2022
SU4.9	YuBa	SURFEX code contributions	End 2022
SU4.10	KpNi	SURFEX code contributions	End 2022
SU4.11	MeSH	SURFEX code contributions	End 2022

Non-t-code deliverables

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

ACCORD WorkPackage description : SU5

WP number	Name of WP
SU5	Assess/improve quality of surface characterization
WP leaders	**Patrick Samuelsson, Ekaterina Kourzeneva, Rafiq Hamdi, Bogdan Bochenek, Adrien Napoly**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
SaVi	Samuel Viana	AEMET Spain	1
EkKo, OlSa	Ekaterina Kourzeneva (1.0), Olli Saranko (1.0, HERCULES*)	FMI Finland	2
BoPa	Bolli Palmason	IMO Iceland	2.5
JodVr	John de Vries	KNMI Netherlands	3
PaSa	Patrick Samuelsson	SMHI Sweden	1
StSc, SaOs	Stefan Schneider (1.0), Sandro Oswald (1.0)	ZAMG Austria	2
DuUs	Duygu Üstüner	MGM Turkey	3
GeBe	Geoffrey Bessardon (2.0), Emily Gleeson (0.5)	MET Eireann	2.5
DiTz	Diane Tzanos	Météo-France	10
TeVa	Teresa Valkonen	MET Norway	0
RaHa	Rafiq Hamdi	RMI Belgium	1

WP objectives

The main objective is to assess and improve quality of surface characterization.

The surface physiography data currently used are:
1) different versions of ECOCLIMAP, from ECOCLIMAP 1 to ECOCLIMAP SG (Second Generation), depending on CSC,
2) the FAO, HWSD and Soilgrids sand, clay and soil-organic carbon databases,
3) the GMTED2010 orography,
4) the Global Lake DataBase (GLDB) v1-3.
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 CSCs. 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.
Physiography is an area where the potential of Machine Learning techniques is now explored. Specific related tasks are organised under the Machine Learning WP, ML1.
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. Studying of urban areas. Improving ECOCLIMAP over China. Impact studies are also described in MQA3.	BoPa, SaTi (MQA3), StSc, SaOs, RaHa	database, reports, documentation, code
SU5.2	Soil maps activities. Soilgrids corrections and studying impact. Corrections will be done mainly for Denmark, Iceland, Greenland, Svalbard, Scandinavia. Orography GMTED2010 in MF models. Impact studies are also described in MQA3.	BoPa, SaTi (MQA3)	database, reports, documentation, code
SU5.3	Tree height data activities. Suggest and apply suitable combinations of tree height data.	MaHo, GeBe	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. Impact studies are also described in MQA3.	DiTz, PaSa, SaVi, JodVr, EkKo, OlSa, SaTi (MQA3), MaHo, SaOs, GeBe, DuUs	report
SU5.6	Tools, and their documentation, for handling of physiography data, including ML applications.	GeBe, BoPa, SaOs, JodVr	

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 2022

SU5.2	BoPa	updated databases, related h-code, reports	End 2022
SU5.3	MaHo	report	End 2022
SU5.4	EkKo	report, updated databases, related h-code if necessary	End 2022
SU5.4	EkKo	report	End 2022
SU5.5		report	End 2022
SU5.7	GeBe	report	End 2022

ACCORD WorkPackage description : SU6

WP number	Name of WP
SU6	Coupling with sea surface/ocean
WP leaders	**Patrick Samuelsson, Bogdan Bochenek, Ekaterina Kourzeneva, Sylvie Malardel**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
SyMa, LaCo, SoBi, CiLB, MNBo, MaMa, FrBo	Sylvie Malardel (2), Laetitia Corale (11), Soline Bielli (0.5), Cindy Lebeaupin-Brossier (5), Marie-Noëlle Bouin (2), Maeva Marquillie (11), François Bouttier	Météo-France	31.5
MaLi, PeSm, AnFe, JuCe	Matjaž Ličer, Peter Smerkol, Anja Fettich	ARSO Slovenia	0
ErTh, NiSz, MaMu, CyPa, YuBa	Erin E. Thomas (xx pm, Nansen Legacy*, FOCUS*), Malte Müller (xx pm, Nansen Legacy*, FOCUS*), Yurii Batrak (xx pm, Nansen Legacy*, FOCUS*)	MET Norway	0
BaKSa	Basanta Kumar Samal (SEAI (Sustainable Energy Authority Ireland)*)	MET Eireann	0
PaSa	Patrick Samuelsson	SMHI Sweden	1

WP objectives

The main objective is to coordinate development with respect to coupling to wave and ocean models:

- 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 and global forecasts. 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). The AROME and SURFEX modifications which are necessary for the AROME-NEMO coupling have been introduced in CY48t1.
In 2020-2021, in the frame of a R&D collaborative CMEMS (marine.copernicus.eu) work between CNRM and Mercator Ocean International, the AROME-NEMO coupling has been updated for cy43, and implemented for a configuration over Western Europe at 2.5 km-resolution for mainly operational oceanography oriented purposes. This coupled system uses the same SURFEX-OASIS interface than previously developed, but now adds the coupling of the atmospheric pressure that plays on the inverse barometer approximation, and includes the current feedback effect on the atmospheric turbulence. Applied for a long-term forecast (7 days) over a severe weather events period, the fully coupled simulation reproduces quantitatively well the spatial and temporal evolution of the near surface parameters in both ocean and atmosphere. A paper that details the results has been recently submitted to NHESS (Pianezze et al. https://doi.org/10.5194/nhess-2021-226).

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 ACCORD 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
SU6.1.3	Validation of Arome-NEMO (see also E11.5)	MaMa, FrBo	
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	Continued development and evaluation of coupled HARMONIE-AROME-OASIS- setups 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 2022
SU6.1.2	SyMa	cy??	2022
SU6.2.1	PeSm	cy43	End 2022
SU6.3.1	BaKSa	cy43	End 2022
SU6.3.2	MaMu, BaKSa	cy??	End 2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SU6.2.1		report	summer 2022
SU6.2.2		report	End 2022

ACCORD WorkPackage description : E6

WP number	Name of WP
E6	Ensemble calibration by use of machine learning and deep learning algorithms
WP main editor	**Henrik Feddersen, Inger-Lise Frogner, Clemens Wastl, Laure Raynaud**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
KiWh	Kirien Whan	KNMI Netherlands	1
MaSc	Maurice Schmeits	KNMI Netherlands	1
EmSa	Emine Say	MGM Turkey	3
JBB	John Bjørnar Bremnes (* also ext MetCoOp)	MET Norway	2
ClBr, LaRa,POESY	Clément Brochet (8) , Laure Raynaud (1) , POSTDOC POESY (8)	Météo-France	17
OlMe, MiZa, MaTa, LePf	Olivier Mestre (4), Michael Zamo (4), Maxime Taillardat(4), Léo Pfitzner (4) : DirOP/COMPAS	Météo-France	16
MaDa, AiAt, IrSc	Markus Dabernig, Aitor Atencia, Irene Schicker	ZAMG Austria	3

WP objectives

Statistical calibration of LAM EPS data is a way of reducing model-specific systematic errors in areas with adequate observation coverage. For establishing statistical significance for the forecasting of severe (rare) events, ideally one should use ensemble re-forecasting over a climatologically relevant period (~30 years). However, this is prohibitively costly in terms of computer resources. We have therefore adopted simpler forms of calibration, which may be less capable of accounting for weather extremes, or perform less well in spatially heterogeneous terrain. In its present implementation in HarmonEPS, calibration is done for screen-level temperature and wind and precipitation. Spatially variable corrections are applied over the entire grid, not only in observation points, as it is seen as important to have calibrated forecasts everywhere and not only at observation sites. In spatially highly heterogeneous conditions, e.g. in mountain areas or at land-sea transitions, calibration is still problematic. Attention will be paid to the introduction of more advanced methods which are better capable of handling areas of such strong spatial inhomogeneity, as well as to the extension of the calibration to a wider range of parameters, such as visibility and gusts. During the last few years, advances have been made on several issues. More advanced methods like random forest, gradient boosting, and lately also neural networks have been applied and show promising results. Features derived from digital elevation models and land cover data have been created and can be used to partly explain spatial variations in the model error. Low quality measurements from private networks have increased the number of measurements extremely and proved useful, especially in otherwise sparse regions. The main challenge is to combine all of these; the computational aspects are of particular concern. More work is therefore needed.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E6.1	Apply recent and more flexible calibration methods that ideally are able to utilize all available input data with the overall aim of making calibrated forecasts at any point. The methods should be adapted so that training on very large data sets, including high-resolution gridded analyses, and prediction at millions of grid points is feasible in operational environments.	JBB, KiWh, MaSc, EmSa, MaDa, **LaRa**	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	Non-t-code
E6.3	Develop, implement and verify calibration methods for probabilistic AROME-EPS forecasts. Innovative methods using machine learning algorithms (random forests, neural networks, etc) are sought. Application is extended to new parameters : wind, temperature, etc.	OlMe, MiZa, MaTa, AiAt, LePf	Non-t-code
E6.4	Generation of ensemble members by deep learning approaches (GAN or auto-encoders): evaluation for extending AROME-EPS members, for pdf dressing and for calibration	**ClBr**, IrSc, **POESY**	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	2022
E6.2	JBB	Calibration code	2022
E6.3-4	MF scientific staff	scientific notes and papers, namelists	

ACCORD WorkPackage description : E7

WP number	Name of WP
E7	Develop user-oriented approaches
WP main editor	**Henrik Feddersen, Inger-Lise Frogner, Clemens Wastl, Laure Raynaud**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
GeSm, JvdB	Geert Smet (1), Joris van den Bergh(1.5)	RMI Belgium	2.5
HeFe	Henrik Feddersen	DMI Denmark	1.5
CeAm, ArGa, LaRa, ArMo, MaPl, YEO, BaAl, IvAl, MaPo, AAA	Cédric Amoré (1), Arthur Garreau (8) , Laure Raynaud (4) , Arnaud Mounier (8) , Matthieu Plu (1), Youness El Ouartassy (8) , Bastien Alonzo (1.5), Ivana Aleksovska (6), Matteo Ponzano (8) , Albert-Aguilar Alexandre (3)	Météo-France	48.5
HuMa, FrBt	François Bouttier (2), Hugo Marchal (8) : CNRM/GMME	Météo-France	10
ChWi, FlWe, ChZi	Florian Weidle, Christoph Zingerle	ZAMG Austria	1.5
SiVe	Sibbo vd Veen	KNMI Netherlands	1
SiTa	Simona Tascu	Meteo Romania	2
AkJo, DaYa	Åke Johansson (5.75) and Daniel Yazgi (1)	SMHI Sweden	6.75
AlCa, MaCo, JuGo, JoMo	Alfons Callado-Pallarés (0.5), Maria Cortes (0.5), Juanjo Gomez (0.5), Joan Montolio (0.5)	AEMET Spain	2
EnKe, IrOd	Endi Keresturi, Iris Odak Plenković	DHMZ Croatia	3
MaBe	Martin Belluš	SHMU Slovakia	1

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 by providing relevant and understandable probabilistic products, 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**, MaPl, FlWe	scientific publication, trained neurals networks
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, AAA**, **ArGa**, **LaRa**, MaPl, ChZi, AlCa, JoMo	
E7.3	Development of decision making criteria for renewable energy: power cut outs, solar energy production probabilistic forecast (SMART4RES).	GeSm, JvdB, **LaRa**, **BaAl, IvAl**	report
E7.4	Development of decision making criteria for agriculture: coupling EPS wi	**LaRa**, postdoc to be recruited	report
E7.5	Development of decision making criteria for hydrological applications: ...	HuMa, FrBt	
E7.6	Development of decision making criteria for transportation safety (road, aviation, etc.). Force a road weather model with a mini ensemble of convection-permitting models. Convective objects synthesis for aviation safety. Coupling of a road surface model into the SURFEX component of the AROME-EPS system, for probabilistic forecasts of road/airport surface state in winter conditions, including anthropogenic forcings.	JvdB, AkJo, DaYa, SiVe, ChWi, ChZi, **MaPo**, LaRa, FrBt, PhD to be recruited, FlWe, ChZi	scientific publication(s) /report(s)
E7.7	Development of decision making criteria for Tourism, Event support (e. g. festivals, sport events, etc.)	ChZi	
E7.8	Use of ensemble forecasts for emergency dispersion modelling (nuclear or chemical): The objective is to design a small ensemble from AROME-EPS 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, **YEO**	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, JuGo	

E7.10	Continuation work on analog-based post-processing method to improve the point or gridded 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 A-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	

ACCORD WorkPackage description : E8

WP number	Name of WP
E8	EPS preparation, evolution and migration
WP main editor	**Henrik Feddersen, Inger-Lise Frogner, Clemens Wastl, Laure Raynaud**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
LaRa, GrRo, OlNu	Laure Raynaud (1) , Grégory Roux (8), Olivier Nuissier (4)	Météo-France	13
MoJi, BaAl	Mohamed Jidane, BadrEddine Alaoui	Maroc Meteo	4
GaTo	Gabriella Toth	OMSZ Hungary	4
KJR	Katalin Javorne Radnoczi	OMSZ Hungary	6
ClWa	Clemens Wastl	ZAMG Austria	2
FlWe	Florian Weidle	ZAMG Austria	2
AlGu	Alper Güser	MGM Turkey	3
MaBe	Martin Belluš	SHMU Slovakia	4
MaDe	Maria Derkova	SHMU Slovakia	1
OlVi	Ole Vignes	MET Norway	1
UlAn	Ulf Andrae	SMHI Sweden	1
SiTa	Simona Tascu	Meteo Romania	2

WP objectives

Preparation, evolution and migration of (i) EPS versions of the canonical system configurations, and (ii) operational AROME and ALARO based EPSs at the HPCF at ECMWF.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E8.1	Maintenance and evolution of the AROME-EPS-France system: follow adaptations for e-suites, porting to next MF HPC & mirror suite	**LaRa**, **GrRo**	non-t-code
E8.2	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**, MoJi	technical notes at this stage
E8.3	Optimization and tuning of operational AROME based EPS system C-LAEF on cy43t2 at ECMWF HPC. Possible extension of C-LAEF (members, domain, lead times).	FlWe, ClWa	non-t-code
E8.4	Introduction of ensemble data assimilation into convection-permitting ensemble system at OMSZ. Continuous tuning and optimization.	GaTo, KJR	non-t-code
E8.5	Adaptation of C-LAEF to Turkish Domain	AlGu	non-t-code
E8.6	Implementation of ENS BlendVar assimilation method in the A-LAEF system to improve the simulation of upper-air ICs uncertainty	MaBe, MaDe	non-t-code
E8.7	Where needed, introduce system changes to support required HarmonEPS development.	OlVi, UlAn	non-t-code
E8.8	Moving of A-LAEF TC2 system to the new HPCF in Bologna and its upgrade to cy43 (or higher if available)	MaBe, SiTa	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
8.[1-2]	MF scientific staff	scientific notes and papers, namelists	
E8.3	FlWe, ClWa	scripts, verification results	2022
E8.4	ViHo, KJR	scripts, verification results	2022
E8.5	AlGu	report, scientific study	2022

E8.6	MaBe, MaDe	scripts, different probabilistic products	2022
E8.7	OlVi, UlAn	Support	Cont.
E8.8	MaBe	scripts, report	2022

ACCORD WorkPackage description : E9

WP number	Name of WP
E9	Model perturbations
WP main editor	**Henrik Feddersen, Inger-Lise Frogner, Clemens Wastl, Laure Raynaud**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
LaRa, LaDe, LeDz, OlNu	Laure Raynaud (2), Laurent Descamps (2) , Lena Dziura (11), Olivier Nuissier (3): CNRM/GMAP	Météo-France	18
FrBt, AxFl	François Bouttier (4), Axelle Fleury (4.5) : CNRM/GMME	Météo-France	8.5
JaKa	Janne Kauhanen	FMI Finland	3
KaHa	Karoliina Hamalainen	FMI Finland	3
PiOl	Pirkka Ollinaho	FMI Finland	1
SvdV	Sibbo van der Veen	KNMI Netherlands	3
WdR	Wim De Rooy	KNMI Netherlands	0.75
JaBa	Jan Barkmeijer	KNMI Netherlands	0.5
ArTs	Aristofanis Tsiringakis	KNMI Netherlands	6
AlHa	Alan Hally	MET Eireann	2.5
JaFa	James Fannon	MET Eireann	1.5
ILF	Inger-Lise Frogner	MET Norway	3
~~TeVa~~	~~Teresa Valkonen (* Alertness)~~	MET Norway	
~~OlVi~~	~~Ole Vignes~~	MET Norway	
GeSm	Geert Smet	RMI Belgium	0.5
MiVa	Michiel Vanginderachter	RMI Belgium	2
UlAn	Ulf Andrae	SMHI Sweden	1
ClWa	Clemens Wastl	ZAMG Austria	4.25
EnKe	Endi Keresturi	DHMZ Croatia	
MaBe	Martin Belluš	SHMU Slovakia	1
~~MaIm~~	~~Martin Imrisek~~	SHMU Slovakia	

WP objectives

Study ways to represent uncertainty in the atmospheric model and how to best incorporate this into the models, including SLHD, further optimization of SPPT and further development of the SPP approach (Stochastically Perturbed Parametrization scheme).

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E9.1	Model perturbations for AROME-EPS: assess parameter perturbations, SPPT, SPP. Besides, Axelle Fleury is doing a thesis on stochastic physics parametrizations (turbulence, shallow convection and microphysics) in an academic AROME-EPS framework. Lena Dziura is investigating SPP and other perturbation schemes for AROME-EPS overseas.	LaRa, LaDe, FrBt, AxFl, LeDz, OlNu	t-code & documentation
~~E9.2~~			
E9.3	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
E9.4	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). Make SPP ready for single precision. Tendency diagnostics will be further developed as it offers a very detailed insight into the differences between different perturbations methods.	UlAn, ILF, SvdV,WdR, ArTs,PiOl, AlHa, JaKa, KaHa,OlVi, JaBa, JaFa	t-code
E9.5	Improve stochastic parameter perturbations (SPP) with special focus on convective hazards (e.g. processes in microphysics).	ClWa, EnKe	t-code
E9.6	Work on a flow dependent stochastic perturbation scheme (add perturbations where they are most effective). Investigate the possiblitity of using AI for this perturbation scheme.	ClWa	t-code
~~E9.6~~	~~Implementation of new random number generator (SPG) suitable for LAM EPS environment in ALADIN-LAEF 5km~~	~~MaIm~~	~~t-code~~
~~E9.7~~			
E9.8	Investigate the possibilities of stochastic perturbation of fluxes instead of tendencies. This should be beneficial with respect to the energy balance preservation in perturbed models.	MaBe	t-code

t-code deliverables

Task	Responsible	Cycle	Time
E9.1	LaRa		
~~E9.2~~			
E9.4	UlAn	Current version in CY48T2 and merged with ECMWF in CY49	
E9.5	ClWa	CY43T2	2022
E9.6	MaBe	CY40T1	2022
~~E9.7~~			
E9.8	MaBe	CY40T1	2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E9.1	MF scientific staff. Comment: the work on SPP is part of Meryl Wimmer's PhD	scientific notes and papers, namelists	
E9.3	GeSm	HarmonEPS configuration test (namelist changes)	End 2021

ACCORD WorkPackage description : E10

WP number	Name of WP
E10	Initial condition perturbations
WP main editor	**Henrik Feddersen, Inger-Lise Frogner, Clemens Wastl, Laure Raynaud**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PiBr, VaVo, OlGu	Pierre Brousseau (1), Valérie Vogt (1), Oliver Guillet (1)	Météo-France	3
PaEs	Pau Escriba	AEMET Spain	1
ILF	Inger-Lise Frogner	MET Norway	1
UlAn	Ulf Andrae (* MetCoOp)	SMHI Sweden	1
RoRa	Roger Randriamampianina (*)	MET Norway	0
JeBo	Jelena Bojarova (* qCONDOR)	SMHI Sweden	0
MaLi	Magnus Lindskog (* MetCoOp)	SMHI Sweden	0
MaBe	Martin Belluš	SHMU Slovakia	1

WP objectives

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

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E10.1	Link with AROME EDA: use AROME EDA perturbations in AROME-EPS initial conditions	LaRa, GrRo, PiBr, VaVo, OlGu	non-t-code
E10.2	Optimize the EDA scheme with respect to the uncertainties of both observation and background. The aim is 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
E10.3	Finish the migration of LETKF code to CY43 and then CY46 and CY48. Special emphasis in reading FA files from LETKF multi-proc MPI environment. Comparison of EDA, BRAND and LETKF performances.	JeBo, PaEs	Non-t-code
E10.4	Study the error propagation mechanism on meso-scales and how to generate perturbations which represent the error growth.	JeBo	Non-t-code
E10.5	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
E10.6	Preparation of flow-dependent B-matrix for local 3D-Var assimilation systems based on ALARO CMC using A-LAEF operational outputs	MaBe	non-t-code

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E10.1	MF scientific staff	scientific notes and papers, namelists	
E10.2	ILF and RoRa	HarmonEPS configuration test	End 2022
E10.3	JeBo, PaEs	optimal configuration of the variational EPS system	2022-2023
E10.4	JeBo		2022
E10.5	ILF	HarmonEPS configuration test	2022
E10.6	MaBe	scripts, reports, evaluation study	2022

ACCORD WorkPackage description : E11

WP number	Name of WP
E11	Surface perturbations
WP main editor	**Henrik Feddersen, Inger-Lise Frogner, Clemens Wastl, Laure Raynaud**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
HeFe	Henrik Feddersen	DMI Denmark	1
JdV	John de Vries	KNMI Netherlands	3
AnSi	Andrew Singleton	MET Norway	0.5
HaMc	Harold McInnes	MET Norway	7
RaGr	Rafael Grote (* External contribution Nansen Legacy)	MET Norway	0
DaYa	Daniel Yazgi	SMHI Sweden	2.25
JaFa	James Fannon	MET Eireann	1
GeSm	Geert Smet	RMI Belgium	1
FrBt, PhD	François Bouttier, PhD to be recruited (manpower committed in SU6)	Météo-France	
ClWa	Clemens Wastl	ZAMG Austria	0.25

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
E11.1	Uncertainties in vegetation fraction may depend on both vegetation type and season and so different perturbations could be applied depending on those factors, this work will continue in 2022. Work on more sophisticated SST perturbations will continue (dependent on possible external funding!). So far a scaling field derived from a whole year of data has been used, the impact of using monthly / seasonal scaling fields, and / or scaling fields based on most recent information will be tried. The same method could be used for some of the other surface parameters in PertSFC too (VEG, LAI, CV, Z0, ALB, TS, WG, SNOW). Perturbations to sea ice will be explored if time.	RaGr, HeFe, GeSm, HaMc, DaYa, JaFa	t-code
E11.2	Extend SPP to surface parameters. Surface physics (if time): 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
E11.3	Towards consistent surface and upper-air surface perturbations, in connection with development of surface EnKF scheme (see SU1)	JeBo	t-code
E11.4	Improve uncertainty representation of surface processes in convection permitting C-LAEF system (e.g. new perturbations, new methods)	ClWa	t-code
E11.5	Benefits of using a time-evolving and/or coupled ocean surface, using the AROME-EPS coupled with 3D NEMO ocean model over a European domain => accounted for in SU6.1.3	FrBt, PhD	

t-code deliverables

Task	Responsible	Cycle	Time
E11.1	HaMc		2022
E11.2	AnSi		2022
E11.3	JeBo		?
E11.4	ClWa	CY43T2	2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time

ACCORD WorkPackage description : E12

WP number	Name of WP
E12	Lateral boundary perturbations
WP main editor	**Henrik Feddersen, Inger-Lise Frogner, Clemens Wastl, Laure Raynaud**

Table of participants

(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)

Participant Abbreviation	Participant	Institute	PersonMonth
HeFe	Henrik Feddersen	DMI Denmark	2
PiCe, CaLa	Pierrick Cébron (8) , Carole Labadie (8) : CNRM/GMAP	Météo-France	8
MaBe	Martin Belluš	SHMU Slovakia	1

WP objectives

Optimize use of lateral boundaries from global model

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
E12.1	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
~~E12.2~~	~~The humidity perturbations will be studied closer and we will investigate methods that don't lead to unrealistic dry conditions.~~	~~HeFe~~	~~non t-code~~
E12.3	Improvements of the global ARPEGE-EPS, as the coupling system of AROME-EPS.	**PiCe, CaLa**	t-code
E12.4	Preparation of perturbed lateral boundary conditions for the LACE domain using A-LAEF TC2 to enable coupling of convection-permitting ensemble systems on local HPC's of RC LACE partners	MaBe	non t-code

t-code deliverables

Task	Responsible	Cycle	Time
E12.3	PiCe		

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
E12.1	HeFe	Algorithm	End 2022
~~E12.2~~	~~HeFe~~	~~configuration~~	~~End 2021~~
E12.4	MaBe	scripts	2022

ACCORD WorkPackage description : MQA1

WP number	Name of WP
MQA1	Development of HARP
WP main editor	**Carl Fortelius, Andrew Singleton**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
CaPe	Carlos Peralta (1 pm)	DMI Denmark	1
AlDe	Alex Deckmyn (3 pm)	RMI Belgium	3
AnSi, LeØs	Andrew Singleton (4.5 pm), Lene Østvand (1 pm)	MET Norway	5.5
ChZi, FlWe	Christoph Zingerle (0.5 pm), Florian Weidle (0.5)	ZAMG Austria	1
RaBR	Rahma Ben Romdhane (3)	INM Tunisia	3
FiSv	Filip Švábik	CHMI Czech	2.5
MaPe	Martin Petras	SHMU Slovakia	1.5
CaFo	Carl Fortelius	FMI Finland	0.5
IrOd	Iris Odak Plenković	DHMZ Croatia	0.5
DaYa	Daniel Yazgi	SMHI Sweden	0.5
FaSi	Fabiola Silva (3)	IPMA Portugal	3

WP objectives

HARP (Hirlam-Aladin R-package) is a verification toolbox first developed in the Hirlam and Aladin consortia. HARP consists of a number of installable R-packages for in/output, point and spatial verification and visualization. These R-packes are kept in github and provided to work with tidy data together with examples and tutorials on the web as well as in workshops. See: https://harphub.github.io/harp_tutorial/index.html

Continuous code maintenance and devlopment, as well as assessment, improvement and extension of the EPS, point and spatial verification methods and tools according to user demand will continue in 2022 and beyond. Documentation and support for users is of high priority, and to this end up-to-date tutorials and manuals are maintained on github and an online harp book will be compiled. I addition a and a harp workspace is active on harp-network.slack.com, where users can help each other and give feedback to the developers and potentially contribute to developments. It will also help developers to keep in touch with each other's work better. A harp training course will be arranged in 2022.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
MQA1.1	Harp User Support Work will continue on an online harp book that is currently based on the first harp training course. The book will cover all aspects of harp as well as data wrangling / analysis using existing functionalities in R. The book will take readers through reproducible examples and be accompanied by data to run the examples. A training course will be organized for new harp users, but also cover topics that existing users may not be aware of. A harp user group will be formed with the aim of establishing a set of 'super users' spread across ACCORD institutes.	AlDe, ChZi, AnSi, FiSv, DaYa, IrOd	documentation, code, meetings, User training events
MQA1.2	Harp code development Introduce new harp packages and abstract out appropriate code from existing packages: harpMethods for classes, methods and functionalities that don't fit elsewhere, harp for wrapper functions that are currently in harpPoint and harpSpatial, and harpShiny for shiny apps that are currently in harpVis.	AlDe, ChZi, AnSi, LeØs, MaPe, FaSi	code
MQA1.3	Harp enhancement Implementation in harp of the developments in WP MQA2 (development of new verification methods/metrics – spatial verification of EPS's) and score cards: e.g. spatial verification of cloud cover for ensemble forecasts using NWC-SAF satellite cloud data and Brightness Temperature; Introduction of neighbourhood-based CRPS (Stein et al, MWR, to appear)	AlDe, ChZi, AnSi	code

MQA1.4	MQA1.4 harp standard verification set The aim is to facilitate the use of Harp by providing scripts and/or harp wrapper functions for easy generation and presentation of a standard set of deterministic and probabilistic scores. The standard set should be suited to the evaluation of operational forecasts and experiments alike, and should require a minimum of intervention by the user. It should be able to replace currently-used verification tools, and Monitor (https://hirlam.org/trac/wiki/HarmonieSystemDocumentation/PostPP/Verification) should be used as a template for defining the scope. Extraction of observations and forecasts into files readable by harp, as well as other necessary adaptations to the RCRs will be done in task SY2.13.	FlWe, CaPe, RaBR	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.	2022
MQA1.2	AnSi	HARP training course	Q1 2022
MQA1.3	AnSi	Hosting of HARP user group	continuous
MQA1.4	AlDe, ChZi,AnSi	Code update for harp, tools for deterministic, EPS and spatial verification are available.	2022
MQA1.5	AlDe, ChZi,AnSi, Daya	Code for spatial tools for EPS will be available in the same manner as for the spatial and EPS parts.	2022
MQA1.6	FlWe, CaPe	Contents and prototype code of a Harp standard verification set	2022

ACCORD WorkPackage description : MQA2

WP number	Name of WP
MQA2	Development of new verification methods
WP main editor	**Carl Fortelius, Joël Stein**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
HeFe,CaPe	Henrik Feddersen (0.5), Carlos Peralta (0.5)	DMI Denmark	1
GeGe, PiWa	Gertie Geertsema (4), Ping Wang (1)	KNMI Netherlands	5
AlDe	Alex Deckmyn (1)	RMI Belgium	1
JoSt, FaSt	Joël Stein (4), Fabien Stoop (4) : DirOP/COMPAS	Météo-France	8
GhFa, FlSu	Ghislain Faure (0.5), Florian Suzat (3)	Météo-France	3.5
DaYa	Daniel Yazgi	SMHI Sweden	0.5
ChZi, PhSc, ChWl	Phillip Scheffknecht (1.5), Christoph Wittmann (0.5)	ZAMG Austria	2
BoTs, MiTs, KoMl	Boryana Tsenova (1), Milen Tsankov (1), Konstantin Mladenov (1)	NIMH Bulgaria	3
CaFo, Kaha	Carl Fortelius (3), Karoliina Hämäläinen (1.5)	FMI Finland	4.5

WP objectives

This work package concerns the development and trial of new verification methods and displaying of results for potential application in all CSCs - The density of standard meteorological observation networks, ground based or based on radiosondes, is far too low to represent the smallest scales of motion predicted by convection permitting models by point verification alone. Therefore neighbourhood based methods are needed to demonstrate the added value provided by high resolution. High resolution analysis and remote sensing observations (such as radar and satellite data) can provide important information on the fine-scale 3D-structure of the atmosphere, in particular about clouds, precipitation and convection. However, each of these data sources has its limitations, and their use typically involves application (or development) of post-processing algorithms (observation operators) providing the model-counterpart of each observation type in use (see wp PH5). It may be noted that much more observations are used for data-assimilation than for verification, and the methods used to compare observations to model counterparts could be extended to cover all forecast ranges. The verification of forecasts over urban areas will call for an increasing attention to data sources and verifiaction methods serving the built-up environment. Spatial verification methods developed for deterministic models will be extended or adopted to high-resolution EPS systems. One simple approach to gain verification information in data sparse areas is to verify EPS against analyses of deterministic models (e.g. ECMWF) (MQA2.3). Score cards will be further developed with respect to verification parameters and scores, as well as significance testing (MQA2.4). New neighborhood-based methods are applied to ensemble forecasts to introduce spatial tolerance in the computation of probabilistic scores, opening a new way to compare deterministic and probabilistic forecasts in MQA.2.5. New remote sensing data sources are utilized in tasks MQA2.6-MQA2.8. MQA2.9 is devoted to expoiting synergies with data assimilation methods.

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	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.	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. "FSS for ensemble forecasts as in Schwartz et.al (2010)", "Spatial agreement score" and "SLX" are candidates for such implementation (DaYa, Hefe, AlDe).	HeFe, AlDe, DaYa	Develop and test code, document results (common code for ACCORD)
MQA2.4	Further development of Score Cards as an efficient way to a summarize the statistical significance of differences between verification scores for different forecasting systems in graphical form. Optimize the selection of verification parameters and scores displayed, emphasizing neighbourhood methods and probabilistic scrores. Look for ways to automate significance testing, and explore using methods that are faster than bootstrapping, e.g. the non-parametric Wilcoxon rank sum test, or parametric test for some scores.	CaPe, GeGe, JoSt, FaSt	Scripts/code (common code for ACCORD) and associated results of new developments
MQA2.5	New neigborhood-based methods are applied to the verification of ensemble forecasts to allow the comparison of deterministic and ensemble forecasts: e.g. a neighborhood-based Brier Score.	JoSt, FaSt	Code, validation study in a peer-reviewed publication
MQA2.6	Further development of tool to generate and present MSG SEVIRI simulated radiance data	PiWa, RulJ, JaFo	Code, user documentation, validation study

MQA2.7	Investigation 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, MiTs, KoMl	Reporting
MQA2.8	Verify wind forecasts at 100 m above ground using doppler radar and lidar data	KaHa	Method and report
MQA2.9	Utilizing synergies with data assimilation in forecast verification: extend the methods of collecting "observation vs first guess or model counterpart" statistics to multiple-range forecasts. This will open the opportunity to verify the forecasts against all available observations, including non-conventional ones, used in data assimilation. E.g. all-sky radiances are known to be sensitive to cloud and precip. forecasts.This task is connected to the DA7.2.	CaFo, **GhFa, FlSu**	Report
MQA2.10	Develop verification methods/tools tailored for extreme event evaluations	ChWi, PhSc	Code

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.	2022
MQA2.2	ChZi, AlDe	Prototype code to be implemented in HARP for spatial-EPS verification (Q1.6)	2022
MQA2.3	HeFe, AlDe, DaYa	Develop and test code, document results (common code for all CSCs)	Dec 2022
MQA2.4	CaPe,GeGe, JoSt, FaSt	scripts/code (common for all CSC's) and results	Dec 2022
MQA2.5	PiWa,RuIJ, JaFo	Code and Validation	
MQA2.6	JoSt, FaSt	publication in international review	2022
MQA2.7	BoTs	Report	2022
MQA2.8	KaHa	Method and report	2022
MQA2.9	CaFo,	Report	2022
MQA2.10	ChWi	scripts/code	2022

ACCORD WorkPackage description : MQA3

WP number	Name of WP
MQA3	Meteorological quality assessment of new cycles and alleviation of model weaknesses
WP main editor	**Carl Fortelius, Christoph Wittman**

Table of participants

(for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)

Participant Abbreviation	Participant	Institute	PersonMonth
GeMo	Gema Morales	AEMET Spain	4
MaKa, EeSa, CaFo	Markku Kangas (2), Eerik Saarikalle (0.25), Carl Fortelius (2)	FMI Finland	4.25
SaTi, WiRo, PiWa	Sander Tijm (1), Wim De Rooy(1), Ping Wang (1)	KNMI Netherlands	3
EmGl	Emily Gleeson	MET Eireann	1
GuNo	Gunnar Noer (1) Ole Vignes (2, MetCoOp RCR contribution)	MET Norway	3
AlCr, AlDu, MiPi, SiTa	Alexandra Craciun (1pm - MQA3.1), Alina Dumitru (1pm - MQA3.1), Mirela Pietrisi (1pm - MQA3.1), Simona Tascu (1pm - MQA3.1)	Meteo Romania	4
AhMe, IvAn ,SuTo	Ahto Mets (1), Ivar Ansper (0.5)	ESTEA Estonia	1.5
HaDh,WaKh,RaRo	Hajer Dhouioui (2), Wafa Khalfaoui (2), Haythem Belghrissi (2)	INM Tunisia	6
MaPe, MaDe	Martin Petras (1.5), Maria Derkova (0.25)	SHMU Slovakia	1.75
FaSt, YaPr, VeLi, JoSt NiMe YvBo, InEt, OlJa, JMP, FrBo, AdNa, OlNu, CeLo, PaMa, LoBe, HaPe, PiBr, NiGi, others: GMAP	Fabien Stoop (4), Yann Prigent (8), Véronique Lion (4), Joël Stein (4) : DirOP/COMPAS Nicolas Merlet (1.5): DirOP/PI (nowcasting) Yves Bouteloup (2), Ingrid Etchevers (2), Olivier Jaron (2), Adrien Napoly (1), Jean-Marcel Piriou (2), Yann Seity (2), François Bouyssel (1), Matthieu Plu (1), Olivier Nuissier (1.5), Eric Wattrelot (3), Cécile Loo (2), Pascal Marquet (2), Pierre Brousseau (1), Nicole Girardot (3), other colleagues from GMAP when needed	Météo-France	42.25
FlMe, FlWe, ChWi, ClWa, PhSc, StSc, NaAw	Florian Meier, Florian Weidle, Christoph Wittmann, Clemens Wastl, Phillip Scheffknecht, Stefan Schneider, Nauman Awan	ZAMG Austria	5
YeCe, DuUs, AlGu, MeSe	Yelis Cengiz (3), Duygu Üstüner (3), Alper Güser (3), Meral Sezer (3)	MGM Turkey	12
SaChi, IsBo	Sara Chikhi (1.5), Islam Bousri (1.5)	ONM Algeria	3
KrKr	Kristina Kryzanauskiene	LHMS Lithuania	2
DaTa, BoTo	David Tajti (2 PM), Boglarka Toth (1 PM)	OMSZ Hungary	3
BoBo, MaKo, PiSe, GaSt, MaSz	Bogdan Bochenek (1), Marcin Kolonko (3), Piotr Sekula (3), Gabriel Stachura (3), Małgorzata Szczech-Gajewska (2)	IMGW Poland	12
IrOd, AnSt, MaHr, AnSl	Iris Odak Plenkovic (1), Antonio Stanesic (1), Mario Hrastinski (0.75), Ana Sljivic (2.5)	DHMZ Croatia	5.25
JuCe, NePr, BeSt, MaLa	Jure Cedilnik, Neva Pristov, Benedikt Strajnar, Matjaž Ličar	ARSO Slovenia	7.5
KII	Karl-Ivar Ivarsson	SMHI Sweden	0.75
GNPe , BoPa, SiTh	Gudrun Nina Petersen, Bolli Palmason, Sigurdur Thorsteinsson a total of 2 pm for MQA3.1 and 3.2	IMO Iceland	2
JuCe, NePr, BeSt, MaLa	Jure Cedilnik, Neva Pristov, Benedikt Strajnar, Matjaž Ličar	ARSO Slovenia	7.5

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, need to be assessed in order to recommend which developments 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 (COM3.1) that are under strong time constraints and - as a consequence - includes only some standard meteorological scores and a limited subjective evaluation.

The task MQA3.1 “System performance monitoring” includes a) regular production of verification and diagnostics from operational systems , b) Pre-operational evaluation of new installations (e-suites) c) coordinated model feedback to the consortium from NWP users , d) 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) Routine production and analysis 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) Pre-operational evaluation of new implementations (e-suites): the changes prepared for the operational models are evaluated 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. E-suite verification encompasses both deterministic and probabilistic systems (EPS), as well as both the global and LAM configurations of MF. c) feedback from coordinated user input, e.g. in the form of user Meetings and reports communicating model experiences from users, e.g. forecasters. d) 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:EeSa,GeMo,XiYa, AhMe, IvAn,SuTo, HaDh,RaRo,CaFo, GNPe , BoPa, SiTh, KIl LACE: SiTa, NaAw, FlMe, PhSc, ClWa, FlWe, ChWi, DaTa, BoTo, MaPe, IrOd, AnSt, MaHr, AnSl MF: FaSt,YaPr, NiMe, OlNu, ErWa, YvBo, InEt, OlJa, CeLo, PaMa, JMP, YaSe, PiBr, NiGi, VeLi, JoSt, MaPl TSMS: YeCe, DuUs, AlGu, MeSe Tu: HaDh, WaKh, HaBe	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. c) Diagnose properties of the ensemble forecast systems, such as spread and error. d) Assess performance on specific weather patterns (for example convective storms or fog but also severe weather cases) to evaluate performance, impact of different processes and possible avenues for improvement.	Harmonie-Arome staff: SaTi, WiRo, KaIv, GeMo,AhMe,IvAn, GNPe , BoPa, SiTh, KIl CSC-Arome staff: ErBa, YaSe, SeRi, YvBo, InEt, OlJa, CeLo, PaMa, JMP, VeLi ZAMG: ClWa, 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) and Meteopole Flux (YaSe, SeRi, ErBa) **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)	Harmonie-Arome staff: MaKa,EmGl, PiWa CAS-Arome staff: ErBa, SeRi, AdNa ZAMG: StSc, FlMe, NaAw	Report on diagnosed issues - proposal for code modifications
MQA3.4	“**Diagnosis of model weaknesses (data-assimilation)** “ Together with the research team in DA (RT2), document the impact of recent data-assimilation techniques on model spin-up. Such techniques may include e.g cloud initialization (including fog), field alignment and 4D-VAR in HARMONIE-Arome or a first evaluation of EnVar + OOPS in a pre-operational context and maybe the assessment of the impact of MTG data in the Arome-France assimilation (or in addition to the Arpège DA).	Harmonie-Arome Staff: RoRa and data-assimilation teams (ex. RT2)	Report on diagnosed issues - proposal for code modifications
MQA3.5	**“ Coordination and follow up “** Staff from the CSCs working 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.	CaFo, Harmonie-Arome staff: SaTi, RoRa,PaSa , LACE: MaDe (0.25) . CSC-Arome:ErBa,YaSe	Recommendations for updates to the RWP (report)

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
MQA3.1a	EeSa,GeMo,XiYa	Reports available to the consortium, e.g. on ACCORD wiki (code updates if needed)	3-4 reports in 2022
MQA3.1b	MF: FaSt,YaPr MetCoOp: CaFo staff from other local teams or operation-syndicates	E-suite reports	
MQA3.2	SaTi, WiRo, KaIv,GeMo	GRIB files with results + verification + source code	December 2022
MQA3.3	MaKa, EmGl ,PiWa, SiTh	Verification , report(s) + source code, GRIB-files with results	December 2022
MQA3.4	RoRa and data-assimilation team	GRIB files with results, verification, code with updates	December 2022
MQA3.5	SaTi, RoRa,PaSa	Report(s) documenting results of initiatives and new cycles	December 2022

ACCORD 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
DaSa	Daniel Santos	DMI Denmark	1
BeUl	Bert van Ulft	KNMI Netherlands	1
OlVi	Ole Vignes	MET Norway	1
NiSo	Niko Sokka	FMI Finland	0.75
PhMa, REK, ThBu	Philippe Marguinaud (2) , Ryad El Khatib (3) , Thomas Burgos (1)	Météo-France	6
OlSp	Oldrich Spaniel	SHMU Slovakia	2
RiJa	Rimvydas Jasinskas	LHMS Lithuania	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.
Also, the use of more complex algorithms, such as 4DVar in data assimilation, will require an analysis of their computational performance to be able to use them in operational environments.

HIRLAM approached the Barcelona Supercomputing Center to establish a close collaboration in the evaluation and optimization of the performance and scalability of the IFS / ACCORD LAM code. Thanks to funding from HIRLAM, a basic evaluation of the performance and scalability of the code was performed, followed by further (joint) investigation of various aspects, such as the implementation of OpenMP. The analysis of both phases of the study will allow to identify areas where to focus the code optimization efforts in the future. The BSC makes its basic scalability and performance evaluation tools available to the ACCORD community and provides training to systems experts in the use of these tools in benchmarking and optimization efforts. These open source code profiling tools can be also used for GPU code profiling (tasks described in SPTR1). Hirlam plans to profile the codes regularly with the BSC tools to evaluate the computational cost of new code contributions and early detection of bottlenecks and optimizing alternatives.

Meteo-France is in close contact with ECMWF to adapt IFS optimizations to the ACCORD 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?
SY1.3	4DVar profilling and optimization for operational uses. Extension zone redefinition. The 4DVar code is available in cy43h2.2 and phased to cy46/cy48	OlVi	Non-t-code
SY1.4	Continue exploring single vs double vs mixed precision studies for cy46/cy48. Discuss the possibility of using SP or MP in Data Assimilation codes	OlVi,DaSa	Non-t-code
SY1.5	Use of the outcomes from the HIRLAM-funded project with Barcelona Supercomputer Center about the Harmonie performance analysis realized in 2020. - Use of Extrae and Paraver for more regular analysis and possible effects of new codes on the computational efficiency - Use of 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 significant bits to evalute the best use of SP, DP or MP codes. - Evaluate the different compilers efficiency in the ECMWF AMD machine	NiSo,RiJa,BeUl,DaSa	Non-t-code
SY1.6	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, ThBu**	non-t-code

SY1.7	Further studies with single-precision versions of the NWP codes for the forecast models	**PhMa, ThBu**, other GMAP staff tbd, OlSp	t-code

t-code deliverables

Task	Responsible	Cycle	Time
SY1.2	REK	CY46T1	2022
SY1.6		CY46T1	2022
SY1.8	PhMa	CY46T1	2022

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SY1.3, SY1.4	OlVi	Report and fixes	2022
SY1.5	DaSa	Reports and code optimization options	2022

ACCORD 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
DaSa	Daniel Santos	DMI Denmark	3
NiSo	Niko Sokka	FMI Finland	3
BeUl	Bert van Ulft	KNMI Netherlands	2
EoWh	Eoin Whelan	MET Eireann	2.5
OlVi	Ole Vignes	MET Norway	
RoSt	Roel Stappers	MET Norway	
TrAs	Trygve Aspelinen	MET Norway	
ToMo	Toon Moene	KNMI Netherlands	1.5
MaKa	Martynas Kazlauzkas	LHMS Lithuania	1
RiJa	Rimvydas Jasinskas	LHMS Lithuania	2

WP objectives

The Harmonie Reference System consists of source code, scripts, utilities and documentation for deterministic and probabilistic forecasting. A robust Harmonie Reference System which is demonstrably suitable for operational use is the main deliverable of the Hirlam collaboration. In the Harmonie Regular Cycle of Reference (RCR), one or more member services undertakes the responsibility to adopt the latest full release of the Harmonie Reference System as their operational model. The role of the RCR is to ensure and demonstrate the technical and meteorological capability of the model in an operational environment. The responsibility to act as RCR center rotates among Hirlam services, in line with major new releases. Until 2016 the RCR commitment only involved the deterministic model, but as HarmonEPS is nowadays an integral part of the system it will be included in future RCR commitments as well. 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.

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 maintenance efforts of the CSC part of the Reference System are part of the common code development and maintenance activities, as described in WP COM2.1 and COM2.T. The 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.

The inclusion and testing of new utilities in the Reference System, such as pysurfex, Titan and GribPP, will require adaptations in the scripting and tests to ensure their correct operation and reproducibility of the entire system.

The decision to use GitHub as our source code manager (SCM) requires some effort to establish new working practices and migrate code repositories, including associated documentation. This change to SCM will help achieve the goals also outlined in WP COM2.T. Both the move to GitHub, as well as the continuous updates and improvements in the CSC, will require alternative activities to achieve an efficient transfer of knowledge within the community.

The improvement of post-processing tools, such as gl, and the transition to a better and more modern verification system, HARP, are some of the new goals of this WP.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SY2.1	Consult Hirlam services on agreements to run a Harmonie RCR for CY46	DaSa	Non-t-code
SY2.2	Implementation, monitoring, pre-release validation and testing, release and maintenance of new code contributions, scripting and tools of the Reference System. Support of the Reference system at one or more operational platforms. Technical testing (running testbed daily at ECMWF), and upward phasing of new code to the latest available T cycle.	EoWh,BeUl,NiSo, ToMo	Non-t-code
SY2.3	Test injection of observation data at ECMWF and operational platforms running RCR	ToMo	Non-t-code
SY2.4	Ensure platform equivalence between the Reference system at ECMWF and operational RCR platforms on meteorological aspects	NiSo,ToMo	Non-t-code
SY2.5	Hirlam system O2R/R2O technical support and trouble-shooting guidelines for Harmonie-Arome to ensure smooth operational running. Communication with (not only) NMHS about the progress of local installations of this code, encountered problems and their solution and reporting this to other ACCORD members.	DaSa, OlVi	
SY2.6	HIRLAM GitHub: - Continue to establish new work practices - Migration of code documentation from the hirlam.org wiki to GitHub - Different levels of training to ensure a good transfer of knowledge about git and GitHub	DaSa	Non-t-code

SY2.7	Arrange virtual or presential training Harmonie and its components for newcomers in 2022.	DaSa	Non-t-code
SY2.8	Design and implement Harmonie CSC test in Davaï testing tool on ECMWF	NiSo	Non-t-code
SY2.9	Based on the multirepository strategy: build a prototype for gl and pysurfex as external tools available for the whole consortium.		Non-t-code
SY2.10	Post-processing improvements: - gl: Improve the design of the name list and I / O handling to avoid memory overhead. Exploring better use of pointers rather than copies which would require some coding effort. - gl: For the preparation of boundary conditions, evaluate the possible implementation of the MPI-compliant version that is needed in larger domains. The amount of code required should be considered, as the supported projections are connected to the forecast model setup. - FullPos: Increase understanding of the tool, implement missing functionalities, collaborate in increasing the usability of the tool to encourage its use among some partners. This will reduce the cost of I / O and the need for post-processing currently performed with gl		Non-t-code
SY2.11	More portable versions of harmonie: - Working on Containers using (rootless) for MUSC and Harmonie CY46/CY48	EoWh	Non-t-code
SY2.12	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 of HARP deterministic verification capabilities in MQA1. The long term objective is to use Harp for all verification purposes and to phase out Monitor. Evaluate a different vfld/vobs extraction to increase the model validation capabilities (e.g. high resolution drifting radiosondes). Prototype the sqlite writing of verification files to be used by HARP directly. Authomatization for the production of score for evaluation of new model releases including scorecards.	DaSa	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	2022
SY 2.5	DaSa	Code, Documentation	2022
SY 2.6	DaSa	Scripts	2022
SY 2.13	DaSa	Code	2022

ACCORD 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
DaSa	Daniel Santos	DMI Denmark	1.5
KaSa	Kai Sattler	DMI Denmark	1
NiSo	Niko Sokka	FMI Finland	0.75
AlDe	Alex Deckmyn	RMI Belgium	
YuBa	Yurii Batrak	MET Norway	2
RoSt	Roel Stappers	MET Norway	

WP objectives

A flexible scripting system is a key tool, not only for running the NWP operational suite, but it is also easy to extend to a number of other different potential applications such as nowcasting, reanalysis, or weather modeling. Although we at SY4 want to explore the possibility of converging on a common scripting system for all members of the ACCORD consortium, in the meantime there is a clear need to keep the operational suites and research activities at HIRLAM.

The Harmonie script is a complex system with much legacy code and a variety of scripting languages. Also, these legacy codes have some outdated parts and are a mix of old scripting languages that are not well known to many users. During the last few years we have taken a few steps to rewrite the scripting incrementally. One of these initiatives has led to the PrepLAM approach, which opens the possibility of configuring a system that can use a machine-readable ASCII configuration, such as toml, yaml or json, and emulate the same environment that scripts expect today and the same flow for the programmer. The objective of this approach is to separate the configuration and the logic part of the scripts to facilitate the transparency, interoperability and testability of the scripting system. We hope that these features will also be used as a prototype for the future common scripting system.

The next step will be to continue rewriting the ecFlow configuration and job submission strategy. The rest of the scripting system can be rewritten in smaller increments to be consistent with the system convergence actions in ACCORD described in SY4.

In addition to the modernization of parts of the system, this WP describes the changes necessary to work in a multi-repository environment, which will require a separation of the scripting from the rest of the parts of the system and the work to coordinate the inclusion of modifications that simultaneously affect the source codes and scripting.

Along with the modernization work, new functionalities, such as the use of cmake as standard compilation tool, the management of the OOPS namelists and the ability to handle sub-hourly cycles, as a first step to adapting assimilation methodologies to more frequent observations, will also be objectives to be achieved.

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. - Separation of scripts from common source codes. - Establish procedures to ensure scripting/code compatibility in the commit step and during the model version checkout (bundling).	KaSa,NiSo,DaSa	Non t-code
SY3.2	Introduce more dynamic suite management by ecFlow using the Python API - Establish the most efficient separation between JSON / TOML / YAML configuration files and logic files	RoSt	Non t-code
SY3.3	Continue the scripting to cmake compilation environment and multi repository strategy	RoSt, YuBa	Non t-code
SY3.4	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
SY3.5	Script modifications for OOPS namelist handling	RoSt	
SY3.6	Technical work needed to implement subhourly cycling as first step to subhourly DA. Several test needed to ensure the full funtionality of the different configurations. See also DA5.2	UA	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	2022
SY3.5	DaSa	Scripts	2022

ACCORD WorkPackage description : SY4

WP number	Name of WP
SY4	Towards a more common working environment: explore practical choices, prototyping, scripting
WP main editor	**Daniel Santos-Munoz, Alexandre Mary**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
AlMa, FlSu, GhFa, HaPe, GCO	Alexandre Mary (IL, 2), Florian Suzat (2) , Ghislain Faure (0.5) , Harold Petithomme, GCO team	Météo-France	4.5
NiSo	Niko Sokka	FMI Finland	0.75
DaSa	Daniel Santos	DMI Denmark	1.5
RoSt	Roel Stappers (as part of CA)	MET Norway	0.5
AlDe	Alex Deckmyn	RMI Belgium	0.5
OlSp	Olda Spaniel	SHMU Slovakia	
SuPa	Suzana Panezic	DHMZ Croatia	

WP objectives

This Work Package describes the specific concrete tasks for enabling the evolution of System working practices and tools. Based on the results of the 2021 scripting questionnaire, a long-term strategy and actions must be implemented to converge on a single scripting system.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
SY4.1	Establish the minimum requirements and functionalities that common scripting must fulfill as a result of the analysis of the questionnaire issued in 2021 and subsequent meetings with the Local Team System Representatives (LTSR).	**AlMa,DaSa**	reports
SY4.2	Explore and prototype the different possible solutions to achieve task 4.1: - Evaluate the use of VORTEX for scripting - Evaluate the results of the work on modernization and the separation of the scripting aspects from the core code aspects of NWP described for Harmonie in SY3 - Evaluate solutions like IFSHub - Evaluate the possibility of a prototype of the management of the OOPS namelist	RoSt, DaSa, NiSo, AlDe, **AlMa, GhFa**	reports
SY4.3	Maintenance of the CLIMAKE scripting system available to all ACCORD partners for the computation of PGD and clim-files on the MF HPC platforms, using the local data bases. Further development of this script according to additional needs or suggestions by the partners, and in collaboration with them (eg. DHMZ team).	**FlSu**, **GhFa**, SuPa	script

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
SY4.1	DaSa	reports	2022
SY4.2	DaSa	reports	2022
SY4.3	FlSu	script	2022

ACCORD WorkPackage description : NOREF

WP number	Name of WP
NOREF	Interface and collaboration activity using our NWP components
WP main editor	**Claude Fischer, Jeanette Onvlee, Martina Tudor**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
HePo	Hercule Poirot	RMI Belgium	
JaCi	Jára Cimrman	CHMI Czech	

WP objectives

This additional work package is intended for describing activity in the ACCORD NWP teams, that is not strictly speaking in the scope of the yearly RWP. Nevertheless, we want to give it some visibility within the consortium reporting and this is the WP which LTMs can use to explain such work. Importantly, **the tasks described here will not be accounted for in the ACCORD Central Manpower Register** (thus, it is really only for visibility).

What tasks or activity can LTMs report under this NOREF WP ?
The proposal is to described work at the interface between NWP and another application (possibly not yet officially included in the scope of the RWP activity), or work done for collaboration with other R&D communities (academia, climate national or international groups etc.). Examples are interface with climate modellers, hydrology, the SEE-MHWS initiative ...
The type of tasks one may think of include:
- the involvement of ACCORD NWP staff in support for setting up a specific version of the system
- the involvement in setting up a work plan and/or analyzing its outcomes, in collaboration with the partner team of the project
- the additional work needed for providing feedback of such activity to the ACCORD members, either within official peer-reviewed publications or in ACCORD-internal communication channels (ASW, newsletter, notes etc.)

More generally, we encourage teams involved in such interface activity to provide feedback to the ACCORD management, at any relevant time.

Descriptions of tasks

Task	Description	Participant abbrev.	Type of deliverable
NOREF1.1	Develop a weather-sensitive criminal investigation method.	**HePo**	**picture in front page of Time Magazine**

t-code deliverables

Task	Responsible	Cycle	Time

Non-t-code deliverables

Task	Responsible	Type of deliverable	Time
NOREF1.1	HePo		Q1/1920