ACCORD

A Consortium for COnvection-scale modelling Research and Development

Rolling Work Plan 2023

Table of contents

Introduction to the RWP2023

The following pages of the RWP2023 contain the work package presentations of the ACCORD activity planned in 2023, with the list of participants, the estimated manpower commitments, the descriptions of tasks and elements on the expected outcomes. The preparation by the ACCORD/MG started in early May 2022 (discuss main changes with respect to the RWP2022, agree on specific guidelines and on the time table for redaction). Discussions with the teams and scientists involved in each Area took place in spring and over the summer, under the lead of MG Members and WP co-leads. In the end of August 2022, a first draft version was made available to the LTMs, in order to prepare their manpower commitments.

A few words on the drafting of the RWP2023

In the preparation of the RWP2023, the ACCORD/MG has decided to go for a few changes whose intentions go beyond the editorial layout:

- The Physics Work Packages PH1-2-3 have been totally redefined. Until RWP2022, these three WPs were describing the work on physics parameterizations per CSC (AROME, HARMONIE-AROME, ALARO). They now are defined per group of parameterizations: turbulence (and convection), radiation, microphysics and clouds. Certainly, the three thematics have some intersections. Nevertheless, beyond the new editorial presentation, the MG intends to *organize* the ACCORD-promoted work in 2023 along these three thematics. This intention already was explained to the co-leads and to the teams, whose participation will be instrumental for the implementation. The reorganized efforts on Physics parameterizations also can be viewed as a first concrete step towards increasing exchanges and interoperability and it is coherent with the proposals of the "Physics interoperability roadmap".
- Some of the data assimilation WPs also have been further reorganized in order to more materialize the organization of work along Research Teams and Support Teams. This reorganization is to be continued in 2023.
- At a more general level, the task description has been adapted with a new layout, which now includes specific columns to describe an expected outcome of the year and, when relevant, provide information on code contributions (in terms of timing, not in terms of target T-cycle). WP redactors have received guidelines to formulate the task descriptions in a fairly concrete way, so that the evaluation of their outcome can be more easily evaluated. This somewhat new way of drafting tasks and their outcome required detailed discussions with the teams, and the RWP2023 only partially reflects this change which will have to be continued in the next RWPs.
- The figures of the committed manpower per team have been provided by the LTMs, in liaison with their teams and with MG. A specific new tool has been prepared by the ACCORD CSS, Patricia Pottier, enabling the LTMs to provide their manpower figures in a listed form including the relevant WPs and tasks numbering. The CSS has then translated the figures to the RWP sheets (the deadline for the LTMs was set to 5 October).

Management issues

On the management team side, it is worth mentioning that 2023 will be marked by several important changes in the ACCORD scientific coordination and the support team:

- A new Area Leader for (upper-air) data assimilation activities is expected to be nominated and would start to participate in the MG as of the beginning of 2023. The Call for applications has been launched on 11 October 2022.
- an Area Leader for (upper-air) Physics parameterizations, diagnostic tools and interface thematics is expected to be searched in the first quarter of 2023, provided the ACCORD Assembly approves the "physics interoperability roadmap" as a prerequisite to opening the Call for applications (the ToRs for this position explicitly refer to this roadmap).
- our Consortium Scientific Secretary, Patricia Pottier, will leave for retirement in the middle of the year. Her replacement is currently being investigated at first in MF.

Code management and code releases

At the level of code management and new working methods, 2023 should be a year where a significant number of code developers would be ready (trained) to use the ACCORD source code forge for their contributions to the common codes. Improvements around the DAVAÏ testing tool also should be implemented, both in terms of enhancing the possibilities of the tool and setting up a team of 4-5 persons to support its maintenance. In terms of T-cycles, a new R&D code release CY49T1 is planned whose construction probably will last over a fair part of the 2022-2023 winter and spring. CY49T1 has ambitious targets on the Integration and System side, like to implement a CSC-wide common SURFEX code version or to extensively start using the new tools for building code releases (the forge, DAVAÏ, the bundling concept).

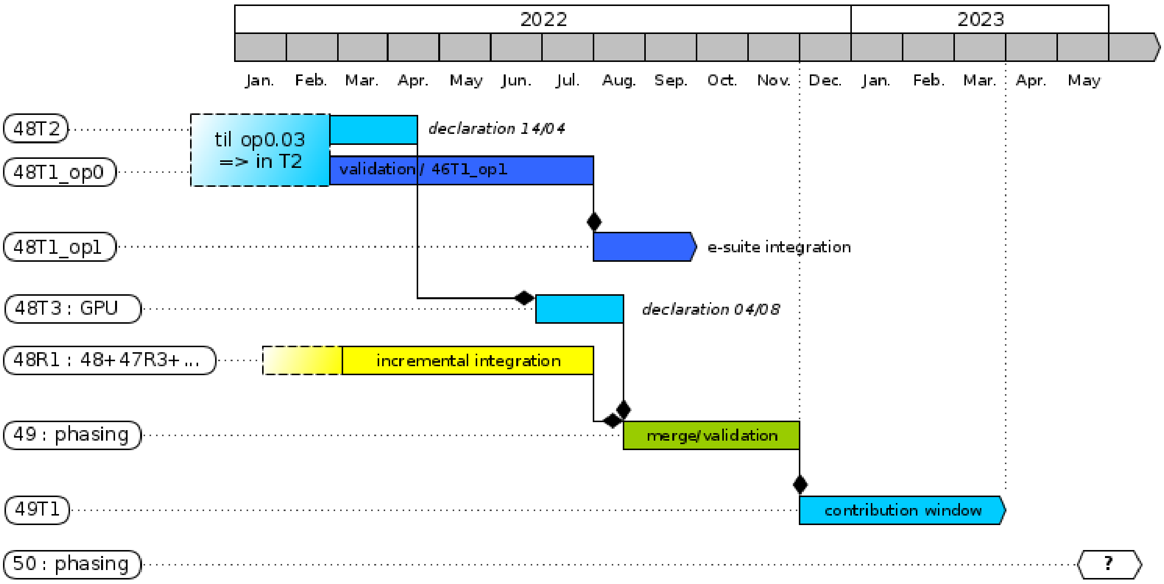
About the link with DEODE

The RWP2023 contains specific figures in the list of participants, related to DestinE/DE_330 funded manpower (aka DEODE). These lines are visible where, in the ACCORD plans, DEODE concretely or potentially can bring results and manpower to ACCORD topics. To be specific here, only DEODE manpower whose tasks (as defined on the DEODE side) can be associated with WPs and tasks on the ACCORD side, are listed. Work and manpower in DEODE, related to topics that do not enter the scope of ACCORD, are not listed in the RWP. The DEODE listed manpower only will be used in order to ease the scientific and technical management by the ACCORD/MG and to derive statistics of manpower for ACCORD bodies. Furthermore, attention is drawn to the fact that the DEODE manpower figures are not intended to be used for DestinE/DE_330 management purposes per se. In accordance with a recommendation from the ACCORD PAC, the following disclaimer is explicitly repeated here:

Disclaimer:
The DEODE estimated manpower figures provided in this document are not representative of decisions or actual figures from the DestinE/DE_330 contracts. They are not deemed to be used or to be representative of the outcome of past, present or future results or negotiations related to the DestinE/DE_330 (aka DEODE) Project. These figures only are meant for ACCORD-internal management purposes.

Annex I: Provisional timeline of common code cycles next year

Hereafter is an overview of the provisional timeline regarding the build of the upcoming common code cycles. The timeline is based on the most recent information from the IFS/Arpege coordination meetings, discussions in MF and in the ACCORD/MG. The timeline might be adapted with respect to any further discussion and decisions within the coordination teams.



Annex II: headlines regarding expected code contributions for the T-cycles in 2023

The bullet-style list below provides an overview of the major code changes which might enter the T-cycles. "major" in this context means either a significant volume of changes (like for code refactoring) or a change associated to a specific improvement of the codes (optimization, a new scientific option, pruning obsolete features).

- in link with SPTR:
  - synchronizing the physics parameterizations of AROME and HARMONIE-AROME with the refactored external PHYEX package (includes validation !), as a preliminary step to its full externalization [SPTR1.1 & SPTR1.2];
  - the ALARO physics will be cleaned and refactored along the lines of the ARPEGE physics (should be completed by the end of 2023, desirable to have the code committed to a T-cycle soon after) [SPTR1.3];
  - *note: cleaning and the refactoring of the the AROME and HARMONIE-AROME physics control routines is expected to start in 2023 and probably will be continued in 2024;*

    - the spectral transforms codes will have received some enhanced options (for HPC-specific functions) for porting to GPU accelerators [SPTR2.1];
    - some parts of the dynamical kernel of the LAM codes might have been refactored, and the refactored codes committed to a T-cycle [SPTR2.2]
    - further refactoring of code under CPG_DRV [SPTR1-2]
- in link with Surface: convergence of versions of SURFEX used in T-cycles and H-cycles, on a so-called SURFEX v8.1+ version
- for LAM/EPS: update the code for SPP to the new code design implemented in the IFS in CY49 (following the proposal by M. Leutbecher/ECMWF in 2018).

Annex III: Work packages and staff resources for 2023

For each Work Package, the total manpower committed for 2023 is given (1st column) and the estimated part of DEODE-funded manpower appears in column 2. Figures in person.months.

WP NUMBER		**WP NAME**	**TOTAL (person/ months)**	**estimated DEODE funded part**
MNGT	MNGT4	ACCORD Management	66.75	0
COM2	COM2.1	Code generation and maintenance: regular maintenance and evolutions, official releases	47.25	0
	COM2.T	Code generation and maintenance: Transition to new work practices and environment	14.5	0
COM3	COM3.1	Maintenance and Partners' implementations of the ACCORD system	91.75	0
	COM3.3	Training (preparation, lectures, attendance)	2	0
	COM3.4	Attendance and preparation of ASW & EWGLAM	0	0
Transversal software developments	SPTR	Addressing future evolutions of software infrastructure	122	76
Towards modelling at (sub-)km resolution	HR	Sub-km modelling	77.75	29.5
Dynamics	DY1	Improvement of SISL spectral dynamical core (H and NH)	22.5	7
	DY2	FVM-like solution as an alternative to SISL dynamical core	15	11
	DY3	Development of methods for solving the implicit equation in gridpoint space	0	0
Data Assimilation	DA1	Further development of 3D-Var (alg. Settings)	72	4.75
	DA2	Development of flow-dependent algorithms	45.5	1.75
	DA3	Use of existing observations	128.25	1
	DA4	Use of new observations types	163.75	7
	DA6	Participation in OOPS (RT1)	43	1
	DA7	Observation pre-processing and diagnostic tools	57.25	2

Physics parametrizations	PH1	Turbulence & shallow convection	56	5
	PH2	Radiation	16.75	0
	PH3	Microphysics and clouds	77	0
	PH4	Common 1D MUSC framework for parametrization validation	3.25	0
	PH5	Model Output Postprocessing Parameters	30	1.5
	PH6	Study the cloud/aerosol/radiation (CAR) interactions	23	0
	PH7	Interface issues between the surface and the atmosphere	27.25	14
	PH8	On the interface of Physics with Dynamics (and time stepping)	2.25	1
	PH10	Fully stochastic physics parametrizations	2.25	0
Surface analysis and modelling	SU1	Algorithms for surface assimilation	33	6
	SU2	Use of observations in surface	34.25	0
	SU3	SURFEX: validation of existing options for NWP	65	26
	SU4	SURFEX: development of model components	5	0
	SU5	Assess/improve quality of surface characterization	35.5	21.5
	SU6	Coupling with sea surface/ocean	23	0
Ensemble forecasting and predictability	E6	Ensemble calibration by use of machine learning and deep learning algorithms	46.5	2
	E7	Develop user-oriented approaches	93.25	0
	E8	EPS preparation, evolution and migration	46.75	0
	E9	Model perturbations	57.75	0
	E10	Initial condition perturbations	13.5	0
	E11	Surface perturbations	32.25	0
	E12	Lateral boundary perturbations	17.25	0
Meteorological quality assurance and verification	MQA1	Development of HARP	18	0
	MQA2	Development of new verification methods	42.5	5.5
	MQA3	Verification, evaluation and error attribution	167.25	10.5
Technical code and system development	SY1	Code optimization	10.25	0
	SY2	Maintenance and development of the Harmonie Reference System	11.5	0
	SY3	Revision of the Harmonie scripting system	17.25	13.75
	SY4	Towards a more common working environment: explore practical choices, prototyping, scripting	32.5	20

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	5.5
CSC-L	Canonical System Configuration (CSC) Leader: ALARO	DHMZ Croatia	5.5
CSC-L	Canonical System Configuration (CSC) Leader: HARMONIE-AROME	KNMI Netherlands	5.5
FrBo, GhFa, ErEs	François Bouyssel, Gislain Faure, Eric Escalière	Météo-France	5
MoMo,	Mohamed Mokhtari,	ONM Algeria	1
ChWi,	Christoph Wittmann,	ZAMG Austria	0.75
AlDe,	Alex Deckmyn,	RMI Belgium	1
BoTs,	Boryana Tsenova,	NIMH Bulgaria	1
AnSt	Antonio Stanešić	DHMZ Croatia	1
RuAn,	Rune Andersen	DMI Denmark	0.75
IvAn,	Ivar Ansper,	ESTEA Estonia	0.75
ReEr,	Reima Eresmaa,	FMI Finland	1
GaSz,	Gabriella Szepszo,	OMSZ Hungary	1
GNPe,	Guðrún Nína Petersen,	IMO Iceland	1
SaVa,	Saji Varghese,	MET Eireann	1
MaKa,	Martynas Kazlauskas,	LHMS Lithuania	0.5
SiSb,	Siham Sbii,	Maroc Meteo	1
BoBo,	Bogdan Bochenek,	IMGW Poland	0.5
MaMo,	Maria Monteiro,	IPMA Portugal	1
AlCr,	Alexandra Craciun,	Meteo Romania	1
MaDe,	Maria Derkova,	SHMU Slovakia	1
NePr,	Neva Pristov,	ARSO Slovenia	1
YeCe,	Yelis Cengiz,	MGM Turkey	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 and priorities

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), the executiuon of the yearly Detailed Action Plan (DAP), the implementation of the Consortium 5-year Strategy, the elaboration of documentation, networking and communication.

About manpower accounting, the work by PM, CSS, CSC Leaders and LTMs should be accounted for, and registered accordingly in the Consortium Manpower Register (CMR), by referencing this MNGT4 work package. The management and coordination work by the scientific Area Leaders should be accounted for in their relevant thematic work packages, as defined in this RWP.

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
MNGT4.1	Execution of GA decisions	PM, MoMo, ChWi, AnSt, RuAn, IvAn, ReEr, ErEs, GhFa, GaSz, GNPe, BoBo, AlCr, MaDe, NePr, YeCe, LTMs as relevant w/r to their local initiatives			
MNGT4.2	Organisation, coordination, minutes of the GA, STAC, PAC, MG meetings	CSS, PM	preparatory documents, minutes & recommendations		
MNGT4.3	Elaboration and execution of the RWP, reporting to the GA	CSS, PM	RWP submitted to GA		
MNGT4.4	Preparation and execution of the annual budget	CSS, PM	budget submitted to GA, yearly DAP (Detailed Action Plan)		

MNGT4.5	Management and monitoring of the contributions of Members (incl. manpower), reporting to the GA	CSS, PM	manpower submitted to GA		
MNGT4.6	Preparation and publication of the Consortium Newsletter	CSS, PM	2 publications/year		
MNGT4.7	Preparation and negotiation of co-operation agreements	PM			
MNGT4.8	Maintenance of the Consortium official web-site where all the relevant information about the project is published	CSS,	website		
MNGT4.9	Scientific & technical coordination within the 8 topical Areas, implementation of corresponding goals of the Strategy, implementation of RWP tasks, coordination with the CSC Leaders	AlMa, PM			
MNGT4.10	Coordination within the CSC teams, link with transversal and topical coordination with PM+AL+IL	CSC-L			
MNGT4.11	Communication and coordination of operational changes of the common system (ARPEGE-AROME) in MF	GhFa,			
MNGT4.12	Coordination of the Consortium activities of their respective national project teams	MoMo, ChWi, AnSt, RuAn, IvAn, ReEr, GhFa, GaSz, GNPe, AlCr, MaDe, NePr, YeCe, LTMs as relevant w/r to their local initiatives			
MNGT4.13	Computing support to Consortium users of MF machines, access to MF machines, offices	ErEs,			
MNGT4.14	Visit of MG members to ACCORD teams who are currently less involved in the DAP (the MG will split, 2 teams would be targeted)	MG members			

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 and Claude Fischer**

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

Participant Abbreviation	Participant	Institute	PersonMonth
DaDe,	Daan Degrauwe,	RMI Belgium	0.25
DaSa,	Daniel Santos,	DMI Denmark	2
AlMa, FlSu, ErWa, YvBo, InEt, OlJa, AdNa, JMP, YaSe, FrGu, MaMa, StMa, PaMo, ChPa, GhFa, REK, HaPe,	Alexandre Mary, Florian Suzat, Eric Wattrelot, Yves Bouteloup, Ingrid Etchevers, Olivier Jaron, Adrien Napoly, Jean-Marcel Piriou, Yann Seity, Frank Guillaume, Maud Martet, Stephane Martinez, Patrick Moll, Christophe Payan, Ghislain Faure, Ryad El Khatib, Harold Petithomme,	Météo-France	40.25
BeUl, ToMo,	Bert van Ulft, Toon Moene,	KNMI Netherlands	2
RoSt,	Roel Stappers,	MET Norway	0.5
BoBo,	Bogdan Bochenek,	IMGW Poland	1.75
MaDe,	Maria Derkova,	SHMU Slovakia	0.5

WP objectives and priorities

This WP lists the major tasks necessary for preparing contributions to the common codes (aka T-cycles), and integrating them in the central repository. This concrete work is currently evolving, from year to year, as the modernized working practices and the new tools are being defined and implemented (ref to COM2.T). For instance, concrete tasks included in this WP could be:
- preparation of codes for the IFS-Arpege-LAM (IAL) project (mostly FORTRAN), and their integration (lead by the IL)
- relevant contributions to other codes required to build full executables for any NWP configuration, like OOPS, Surfex, etc.
=> for the sake of clarity, the above two tasks encompass all local work done for porting a new development from a local development version to the most recent code release, in preparation for its integration (task **COM2.1.3**).
- bundling and building the executables
- testing, technical validation of new code releases, using any of the relevant tools available today (Davaï, others) (task **COM2.1.5**)
- time spent locally on debugging in a new code version (during preparation, integration or local installation) (task **COM2.1.5** and reporting in task **COM2.1.7**)

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.
The WP describes tasks within the environment issued from the transition WP **COM2.T** (modernization of working practices).

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
COM2.1.1	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) 4. follow the list of expected contributions to the next T-cycle (IL with the full MG involved)	DaSa, AlMa, GhFa, MaDe,	(1) planning and inventory documentation under the responsibility of the IL and Sys-AL, (2) minutes of coordination meetings		
COM2.1.2	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.	AlMa, FlSu, FrGu, MaMa, StMa, PaMo, ChPa, REK, HaPe,	New release CY50	IAL	01/07/2023
COM2.1.3	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.	DaDe, AlMa, FlSu, ErWa, YvBo, InEt, OlJa, AdNa, JMP, YaSe, GhFa, BoBo,	New releases CY49T1 and (tbc) CY50T1	IAL	31/12/2023
COM2.1.4	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.	AlMa, RoSt, DaSa,	Scripts, input resources (namelists, initial conditions, etc...) & SP report	DAVAI-tests	31/12/2023
COM2.1.5	Generation of CSCs after a new T-cycle was built and technically validated (from integration phase). - Meteorological validation in near-real time context. - Forward phasing of local add-ons on top of the latest T cycle - Adapting Davaï tests to CSCs evolutions (link with COM2.1.4)	BeUl, ToMo, MF/GMAP staff	local code versions, MQA reporting to newsletter	other repo	
COM2.1.6	Coordination between ACCORD teams about CSCs content and latest operational needs				
COM2.1.7	Reporting, tracking, phasing among branches/releases of bugs and bugfixes	AlMa, GhFa, MaDe,	T-code & tickets	IAL	continuous effort
COM2.1.8	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).	DaSa, AlMa,			

COM2.1.9	Think about documentation in association with the codes: - how to define and how to organise documentation linked to the code commitments and the Pull Requests (PR) - how to define and organize scientific and technical documentation at a more general level and link it with the code evolution	DaSa, AlMa, the ACCORD/MG for the general level	a draft proposal will be part of the "R2O/O2R white paper" prepared by MG		

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 and Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
DaDe,	Daan Degrauwe,	RMI Belgium	1
DaSa,	Daniel Santos,	DMI Denmark	2
AlMa, GhFa, HaPe, PaSa,	Alexandre Mary, Ghislain Faure, Harold Petithomme, Patrick Saez,	Météo-France	10
RoSt,	Roel Stappers,	MET Norway	1.5

WP objectives and priorities

The full NWP System consists of a variety of codes, managed as different projects and repositories (e.g. the models core repository - IAL -, the OOPS repository, the Surfex repository, ...). Developments of the Consortium teams can concern code to be integrated in the models core repository, or in other repos needed to build an executable file, or even in other "satellite" tools (ancillary tools like Epygram or coupling codes like an ocean model). We are exploring modernized solutions for the integration process of code developments (especially for IAL), a source code forge, testing procedure (technical QA), assembling codes from the ecosystem of repos ("bundling"), communication and documentation. This exploration is lead by the IL and the Sys-AL, in close connexion with the MG. Its progress is regularly presented at the ACCORD Governance meetings, which allows to address the potential high-level management questions that can arise (pricing, code policy, management and manpower, link with ECMWF).
The ecosystem of shared repositories used by the ACCORD partners 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.

A team of so-called "Davaï-contributors" will be set up, whose tasks will be to help enhance the technical testing possibilities (by enhancing the functions of Davaï), help maintain the existing tests and support the IL and the Sys-AL in these efforts. The current estimate of manpower for this team is 4-5 staff members (in addition to IL and Sys-AL), among which 2-3 staff could be new colleagues currently not involved in code preparation or code testing (ie not yet involved through specific system organisation within MF, HIRLAM or LACE). The estimated manpower figure per person could be 10% FTE to start.

Other aspects to be considered are a common platform for information exchange, the need for meetings and training.

The overall 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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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. Elaborate and make proposal on how to organise the content of the forge and its management (number of projects, organisation of branches, who is responsible, provide access, role of the MG, system team)	DaSa, GhFa,	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	HaPe, PaSa, RoSt,	Scripts, packages, input resources (files, namelists, etc.) + doc	DAVAI-tests	07/2022
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).	RoSt,	Documentation + adaptation of tools	IAL-build	06/2023
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.	GhFa,	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)	GhFa,	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.		Accessible WIKI solution. A CNRM wiki-based solution is in place since 2021.		

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)	GhFa, RoSt,			
COM2.T.8	**Define vocabulary and describe the testing strategy at ACCORD-level**, as well as how technical quality assurance could be interfaced with meterological quality assurance. This brainstorming would become a part of the "research-to-operations white paper".		document as part of the white paper		
COM2.T.9	**Establish a "Davaï-contributors team".** A specific need is the further enhancement and maintenance of the DAVAÏ technical testing tool: - add new tests - when relevant, update existing tests (provide new input test data, new namelist options) - support the IL and the Sys-AL in assessing results of DAVAÏ tests during the integration phase and on new code releases (especially for expected non bit-reproducible results) - coordination tasks at technical level with scientific experts and with MG members, under the leadership of IL and Sys-AL The tasks will not only focus on the forecast configurations, but also on components of DA and of EPS. Furthermore, the team also should be able to cover many of the components as defined in each of the CSCs. This task is provided as a RWP-marker to make explicit the efforts of setting up this team, then start organizing its activity under the lead of IL and Sys-AL.	DaDe, DaSa,	training for these team members has been done, if needed & the team members have have actively participated in using and updating Davaï tests (for instance for CY50T1)	DAVAI-tests	12/2023

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
WaCh, BeZa, KnEi,	Walid Chikhi, Benghabrit Zakaria, Kerroumi Nour El Isslam,	ONM Algeria	3
ChWi, FlWe, ClWa, FlMe,	Christoph Wittmann, Florian Weidle, Clemens Wastl, Florian Meier,	ZAMG Austria	5
AlDe, MiVa,	Alex Deckmyn, Michiel Vanginderachter,	RMI Belgium	1
BoTs, MiTs, KoMl, AnBo,	Boryana Tsenova, Milen Tsankov, Konstantin Mladenov, Andrey Bogatchev,	NIMH Bulgaria	6
AnBu, AlTr, RaBr, JaMa, PeJa,	Antonín Bučánek, Alena Trojáková, Radmila Brožková, Ján Mašek, Petr Janeček,	CHMI Czech	12
HeFe,	Henrik Feddersen,	DMI Denmark	2
AhMe, IvAn, AlLe,	Ahto Mets, Ivar Ansper, Alina Lerner,	ESTEA Estonia	2
FlSu, ErEs, GhFa, MaMo, PaLa, VeMa, NiMa,	Florian Suzat, Eric Escaliere, Ghislain Faure, Mathilde Moureaux, Pascal Lamboley, Veronique Mathiot, Nicolas Marie,	Météo-France	25
DaLa,	David Lancz,	OMSZ Hungary	6
GNPe, BoPa,	Guðrún Nína Petersen, Bolli Pálmason,	IMO Iceland	2
MoJi, NaMa, KaKa,	Mohamed Jidane, Najlae Marass, Kamal Karouni,	Maroc Meteo	3
TrAs, OlVi, EiSt,	Trygve Aspelien , Ole Vignes, Eivind Støylen,	MET Norway	3
MaLo, VaCo, MaMo,	Manuel João Lopes, Vanda Costa, Maria Monteiro,	IPMA Portugal	5.25
AlDu, AlCr, MiPi, SiTa,	Alina Dumitru , Alexandra Craciun, Mirela Pietrisi, Simona Tascu,	Meteo Romania	4
MaDe, OlSp,	Maria Derkova, Oldrich Spaniel,	SHMU Slovakia	7.5
JuCe, NePr,	Jure Cedilnik, Neva Pristov,	ARSO Slovenia	4
HaBe, WaKh, HaDh, RaBR,	Haythem Belghrissi, Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	1

WP objectives and priorities

The aim of the WP is to support and coordinate the activities leading to the implementation of new code versions at the Members' NMS (aka "export versions"):
- distribute relevant technical information among Partners, provide basic help for local installation or distribute specific tasks when required
- local installation efforts of a new T-code release
- collect reported problems and their solutions and assist in preparation of code bugfixes

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 SCC, 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 COM3.1.1, COM3.1.3-4 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 since 2022 (this task is only kept for ... referring explicitly to MQA3 !).

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
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.	BoTs, MiTs, KoMl, AnBo, MaMo, DaLa, MaDe,			

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.7). 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 SCC or LACE Data Manager to other teams for their local installation - ACCORD teams in general: local installation of a T-cycle version	WaCh, BeZa, KnEi, BoTs, MiTs, KoMl, AnBo, AhMe, IvAn, FlSu, GhFa, MaMo, PaLa, VeMa, NiMa, GNPe, BoPa, MoJi, NaMa, KaKa, VaCo, AlDu, AlCr, MiPi, SiTa, JuCe,	reports about installation of CY46T1 and possibly CY48T1 export versions (newsletter or website)		
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,	updates for a bugfix branch	IAL	2023
COM3.1.4	Preparation and chairmanship of the LTMs meetings	MaDe,	minutes from LTM meetings		
COM3.1.5	Coordination of MF operational changes with Partners	ErEs, GhFa, MaDe,	sensitivity studies using new LBC files from ARPEGE		
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.).	WaCh, BeZa, KnEi, ChWi, FlWe, ClWa, FlMe, BoTs, MiTs, KoMl, AnBo, HeFe, AhMe, IvAn, AlLe, MaMo, PaLa, VeMa, NiMa, MaLo, MaDe, NePr,			
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**.	WaCh, BeZa, KnEi, ChWi, FlWe, ClWa, HeFe, AhMe, IvAn, AlLe, MaMo, PaLa, VeMa, NiMa, MaDe, NePr,	reporting in newsletters, in LTM meetings and perhaps in technical documentation associated with updates of the bugfix branch (the latter items pending on how quickly we can move to new working practices, use the forge etc.)		

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
ClFi	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	
DaSa,	Daniel Santos,	DMI Denmark	0.5
AlMa,	Alexandre Mary,	Météo-France	0.5
HaBe, WaKh, HaDh, RaBR,	Haythem Belghrissi, Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	1

WP objectives and priorities

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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".		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.		tutorial		
COM3.3.3	Training to the new working practices and tools **in link with COM2.T** will have started in 2022 (GIT, forge, Davaï). As required, such training will be repeated and possibly local teams may consider to propagate knowledge and practices in their home groups.	DaSa, AlMa,	tutorial material		

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)	ESTEA Estonia	
CNA	Coordinator for Networking Activities	SHMU Slovakia	
LTMs	Local Team Manager or other staff, committed in MNGT4	ESTEA Estonia	

WP objectives and priorities

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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.		

ACCORD WorkPackage description : SPTR

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PiTe, DaDe,	Piet Termonia, Daan Degrauwe,	RMI Belgium	6
RMINe1, DaDe,	RMI-Newcomer1, Daan Degrauwe,	RMI Belgium/D	15
MaTu,	Martina Tudor,	DHMZ Croatia	2
MaHr,	Mario Hrastinski,	DHMZ Croatia/D	2
RaBr, RaBr, JaMa, JaMa,	Radmila Brožková, Radmila Brožková, Ján Mašek, Ján Mašek,	CHMI Czech/D	5
NiSo,	Niko Sokka,	FMI Finland/D	2
FlSu, SeRi, QuRo, PhMa, JuGr,	Florian Suzat, Sebastien Riette, Quentin Rodier, Philippe Marguinaud, Judicaël Grasset,	Météo-France	24
PhMa, NeMF2, ThBu,	Philippe Marguinaud, NewcommerSPTR, Thomas Burgot,	Météo-France/D	25
NcIe1,	NewcomerIE-1,	MET Eireann/D	9
BeUl,	Bert van Ulft,	KNMI Netherlands	1
RoMy , YoKu,	Rolf Myhre, Yogesh Kumkar,	MET Norway	10
RoMy , YoKu,	Rolf Myhre, Yogesh Kumkar,	MET Norway/D	10
BoBo,	Bogdan Bochenek,	IMGW Poland	3
PiSe, ReMa,	Piotr Sekuła, Remigiusz Majka,	IMGW Poland/D	8

WP objectives and priorities

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. Regular meetings will be organized with ECMWF to keep the developments and plans in accordance.

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. Foremost, the flexibility of the control routines needs to be improved through the introduction of smart (device-aware) data structures and a cleaning and refactoring of the physics parameterization calling routines (SPTR1). For the spectral transforms, which are well-delineated and slowly-evolving, yet crucial for performance, a manual hardware-specific porting and optimization is targeted (SPTR2.1). 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, source-to-source transformation tools will be developed (SPTR2.2) and applied to the individual parameterizations (SPTR2.3).

Atlas is a framework being developed at ECMWF for the handling of data structures in parallel, distributed or heterogeneous hardware environments. Since the full-scale use of Atlas in the IFS is not foreseen for the immediate future, the work in ACCORD on Atlas will be limited to the features that are necessary for the development of a FVM-LAM dynamical core (DY2).

During the process of porting pieces of the ACCORD model to accelerators, it is essential to continously test for the correctness of the results, but also e.g. if the performance on CPU's does not degrade. An extension of the regular testing platform of ACCORD, Davai, in these directions will be investigated.

The Destination Earth Extremes On-Demand (DE_330) project contains a work package (WP2) on code adaptation to EuroHPC infrastructure. Care was taken to align the DE_330 WP2 with this ACCORD rolling workplan, and a substantial workforce should become available in 2023 to accelerate the work in the SPTR work package.

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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. An important constraint is that the vectorization and the performance on CPU-only machines should not be affected in a negative way. The aim of this task is therefore to improve the flexibility of the code in terms of parallelization granularity. The code should be flexible enough to allow both for the existing coarse-grained parallelism with a single top-level OpenMP loop around the physics parameterizations, as well as for a finely granular layout where individual parameterizations are computed in separate parallel regions. This requires a redesign of the dataflow at the control layer routines, using smart hardware-aware data structures, as well as a cleaning and refactoring of the parameterization calling routines. This work has already progressed significantly for ARPEGE; part of it relies on source-to-source transformation tools. This approach will be followed and the tools will be adapted for the ALARO configuration. For the other two CSC's, AROME and HARMONIE-AROME, the codebase is far from being ready to be processed by automatic tools. As will be explained in some detail below, part of the work is relatively straightforward in the sense that a solution has been devised and needs to implemented in the different parameterizations code. On the other hand, for some aspects exploratory work is still needed to identify a suitable solution strategy.	RMINe1, DaDe, MaHr, NiSo, FlSu, SeRi, QuRo, NcIe1, BoBo, RoMy, YoKu, RaBr, JaMa	t-code		

SPTR1.1	Refactoring of AROME parameterizations. This work is done in collaboration with CNRM/GMME where the same parameterizations are used in the MesoNH model. To easen the refactoring and testing, the individual parameterizations have been externalized into a joint AROME/MesoNH repository (PHYEX) and stand-alone drivers have been developed. Reliance on this external repository is foreseen for cy49t1. Aspects of the AROME/MesoNH parameterizations that need to be addressed and for which the solution is known and straightforward are (i) the transition from array syntax to explicit loops; (ii) changing of the layout of the horizontal dimension from 2D (current MesoNH convention) to 1D NPROMA-sliced (AROME convention), (iii) the support for incomplete NPROMA blocks and (iv) the removal of loops over GFL variables ("EZDIAG" in particular) by preprocessed code. Other aspects require more investigations in order to enable automatic processing by scripting tools and efficient running on accelerators: (i) the gathering/packing mechanism ("transposition") in the microphysics and shallow convection scheme, where not all calculations are done in all gridpoints; (ii) the mechanism for budget diagnostics (DDH/budget); (iii) the calls to subroutines contained inside vertical loops, which probably requires an inlining tool; (iv) the recently-introduced use of horizontal gradients in the MesoNH code. After the refactoring of the individual parameterizations in the PHYEX repository, the flexibility of the driver routine APL_AROME will need to be increased in a similar way as was done with the APLPAR/APL_ARPEGE routine for the ARPEGE physics.	NiSo, SeRi, QuRo,		IAL	
SPTR1.2	HARMONIE-AROME refactoring. HARMONIE-AROME parameterizations overlap largely with (or at least follow the coding style as) the AROME parameterizations. A first step therefore is to add the HARMONIE-AROME specific parameterizations into the PHYEX repository and to develop standalone drivers. Afterwards, the HARMONIE-AROME parameterizations need to be transformed along the same lines as those of SPTR1.1.	NiSo, SeRi, QuRo, Ncle1,		IAL	
SPTR1.3	ALARO refactoring. ALARO parameterizations follow the coding style of ARPEGE, but significant cleaning is necessary at the level of the APLPAR routine. This includes removal of obsolete options, moving calculations to (new) subroutines and organizing the calling tree in a more physical-process-based manner.	MaHr, BoBo,		IAL	
SPTR2	Porting of individual pieces of ACCORD codes to GPU's	PiTe, RMINe1, DaDe, NiSo, PhMa, JuGr, NeMF2, ThBu, PiSe, ReMa, , RoMy, YoKu			
SPTR2.1	Porting of biFourier spectral transforms; linking to ECMWF's publicly available ectrans; continue developing and testing of GPU versions for NVIDIA GPU's (OpenACC+cuFFT) and AMD GPU's (OpenACC/OpenMP+rocFFT)	PiTe, ThBu, DaDe	t-code	IAL	
SPTR2.2	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 OpenMP 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 fxtran-based scripts which have been applied already with success to some parameterizations, will be explored further.	PhMa, JuGr, NeMF2, RoMy, YoKu		IAL-build	
SPTR2.3	Porting to GPU's of gridpoint column calculations (physics parameterizations, gridpoint dynamics) in stand-alone mode using the tools developed in SPTR2.2. The drivers from PHYEX (SPTR1.1, SPTR1.2) can be used for this.	PhMa, JuGr, NeMF2,			
SPTR2.4	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.	PhMa, JuGr, NeMF2,			
SPTR3	Atlas developments. Atlas can be considered as a tool with various roles, e.g. interpolation activities, grid/mesh generation, data governance and handling. The focus for 2023 will be on features that are required for DY2 (FVM operators). Also features for SPTR4 (multi-IO server) and DY3 (stencil FD operators) may be developed further.	DaDe,	code in Atlas github repository		
SPTR4	Adapt the IO server or its ECMWF extension called multIO to Atlas; optimize I/O using Atlas tools		t-code	IAL	
SPTR5	HPC access, testing and integration. Seek to get access to a diversity of platforms (NVIDIA GPU's, AMD GPU's, ARM processors, vector accelerators) and perform experiments on these platforms using the stand-alone drivers of SPTR2.3. The pieces of code that have been ported to accelerators (SPTR2) will be integration into the full model and their performance will be evaluated. The source-to-source transformation tools developed in SPTR2.1 will be integrated in the ACCORD build system(s) (gmkpack/cmake). During the refactoring (SPTR1) and the porting to accelerators (SPTR2), it is essential to check the results and the performance on various platforms. Specific testing strategies for various compilers and hardware platforms will be developed, and their integration with the regular ACCORD testing platform Davaï (COM2.1) will be investigated.	DaDe, PhMa, JuGr, NeMF2, RaBr, JaMa	t-code, report	IAL-build	

ACCORD WorkPackage description : HR

WP number	Name of WP
HR	Sub-km modelling
WP main editor	**Jeanette Onvlee, Eric Bazile and Martina Tudor (and Claude Fischer)**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
StSc,	Stefan Schneider,	ZAMG Austria	2
ChWi, PhSc,	Christoph Wittmann, Phillip Scheffknecht,	ZAMG Austria/D	3
DaSa, XiYa,	Daniel Santos, Xiaohua Yang ,	DMI Denmark	1.25
XiYa,	Xiaohua Yang ,	DMI Denmark/D	2
IvAn, AlLe, AhMe,	Ivar Ansper, Alina Lerner, Ahto Mets,	ESTEA Estonia	3.5
RaHo, YaSe, AlDe, MaMd, DiRi, SaAn, BeVi,	Rachel Honnert, Yann Seity, Alan Demortier, Marc Mandement, Didier Ricard, Salome Antoine, Benoit Vie,	Météo-France	26
NeHR,	NewcommerHR,	Météo-France/D	11
BoPa,	Bolli Pálmason,	IMO Iceland	1
CoCl, JaFa,	Colm Clancy, James Fannon,	MET Eireann	2
CoCl, NcIe2,	Colm Clancy, NewcomerIE-2,	MET Eireann/D	6.5
		KNMI Netherlands	3
EMSa, HiHa, YuBa, TeRe, NN-PhD, NN-ext,	Eirik Mikal Samuelsen, Hilde Haakenstad, Yurii Batrak, Teresa Remes, NN-PhD, NN-ext,	MET Norway	6
MaDe, AnSi,	Maria Derkova, Andre Simon,	SHMU Slovakia/D	7
DaMa, JaCa, JJGA,	Daniel Martin, Javier Calvo, Juan Jesus Gonzalez Aleman,	AEMET Spain	3.5

WP objectives and priorities

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. This research is linked to developments on hectometric scale modelling in DEODE.

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 reworking of the SLHD (link with **HR8.4**);
- the provision and use of adequate physiography data;
- the availability and quality of observations suitable for the validation of hyper-resolution models;
- 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 (**DY1-2-3**), 3D-physics (**PH1-2-3**), 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 **PH1-2**). 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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
HR1.0	Set up dedicated hectometric and hyper-resolution (100-200m horizontal resolution) configurations for all three CSCs. Perform experiments with these configurations on various aspects of model behaviour.	ChWi, PhSc, CoCl, NcIe2,	report		
HR1.1	Update and improve the AROME-France 500m configuration with and for the fog experiement and for the airport area such as CDG. Continue experiment 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, NeHR, YaSe, SaAn, BoPa,	namelists		
HR1.2	For all CSCs, compare the model behaviour for various horizontal/vertical resolutions, and compare the model at various hectometric resolutions against LES and observations, to improve model understanding. (Related to new high resolution measured data in DA4 and MQA tasks as well as HR2). This includes participation in relevant field experiments and model intercomparison exercises, such as RDP Paris 2024 and EUREC4A.	ChWi, PhSc, DaSa, XiYa, IvAn, AlLe, AhMe, CoCl, JaFa, NcIe2, EMSa, HiHa, YuBa, TeRe, DaMa, JaCa, JJGA,	report		
HR1.3	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) Tests and validation of redesign in the horizontal/vertical diffusion treatment and SLHD performance at super-resolution 5) Consider the role of horizontal diffusion and SLHD at hectometric scales	CoCl, NcIe2, AnSi,	report, namelist configurations		

HR1.4	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. 4) assessment of the quasi-3D radiation implementation based on a coarse-grid approach using the 3D Spartacus solver in ECRAD (see PH2.11)	RaHo, YaSe, AlDe, DiRi, SaAn, BeVi,	report, namelist configurations SaAn's PhD will finish end of 2022 (PhD manuscript will be in French !) A paper will be re-submitted to Weather & Forecasting		
HR1.5	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).	StSc, NaTh,	report, namelist configurations		
HR1.6	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).	JaFa,	report		
HR2	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. Assess the potential of NetAtmo data to characterize urban heat islands (at the scale of a city). This could later become an entry for developing model verification at city scale (**MQA2** later ?). A bib-ref for the work by Eva M. is here: https://journals.ametsoc.org/view/journals/bams/103/4/BAMS-D-21-0174.1.xml 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**).	NaTh,	In CNRM/GMME, the work on NetAtmo data & urban heat islands is part of EvMa's PhD, deemed to finish in 2023		
HR3	Collect/optimize the model physiographic data for use in hectometric and hyper-resolution configurations (link with **SU5**)		databases		
HR4	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.		report, non-t-code		
HR5	Explore the challenges of how data assimilation in hectometric scale models could be handled. Aspects to be considered: - Handling of artificial wrap-around of anaysis increments (more pronunced if small domain) due to spectral represenatation and periodicity assumption of background error statistics in variational tl/ad formulation. - Scale differences between what is observed and represented by model to be take are of (supermodding or footprint operators). - Explore need for slant path radiative transfer for the assimilation of sounder radiances. - Representation of observation error correlations to enable optimal use of high-density observations. - Observation latency issues. - Predactibility limits at shorter scales and optimal use of host model information to properly initialize larger scales with longer predictability. - Computational affordability issues.				

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
AnSl,	Ana Šljivić,	DHMZ Croatia	1.5
PeSm, PeSm, PeSm, PeSm,	Petra Smolíková, Petra Smolíková, Petra Smolíková, Petra Smolíková,	CHMI Czech	5
PeSm,	Petra Smolíková,	CHMI Czech/D	4
FaVo,	Fabrice Voitus,	Météo-France	4
LuAu,	Ludovic Auger,	Météo-France/D	3
CoCl,	Colm Clancy,	MET Eireann	1
NaSz,	Natalia Szopa,	IMGW Poland	2
AlCr,	Alexandra Craciun,	Meteo Romania	2

WP objectives and priorities

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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.	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.	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.		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).~~		t-code, non-t-code		
DY1.5	Testing the influence of the definition of vertical coordinate eta on the accuracy of vertical interpolation.		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	AnSl, NaSz,	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.	LuAu, CoCl,	non-t-code		

DY1.8	The semi-lagrangian scheme is an important component that enables the use of long timesteps. Several questions must be investigated : a) New interpolation possibilities such as the WENO scheme with quintic interpolations must be tested or other options.b) The departure point computation is another important topic; the current algorithm might not be optimal , a Runge-Kutta method has been implemented at ECMWF, this should be tested and ported, if proved not adapted to our model, an alternative method should be implemented.	FaVo,			

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	Météo-France	4
NeMF1,	NewcommerDY,	Météo-France/D	11

WP objectives and priorities

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.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
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, NeMF1,	non-t code		

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

WP objectives and priorities

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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.		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.		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.		non-t-code		

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
NaAw,	Nauman Awan,	ZAMG Austria	6
AnSt,	Antonio Stanešić,	DHMZ Croatia	1
AnBu, AlTr,	Antonín Bučánek, Alena Trojáková,	CHMI Czech	4
MaDa,	Mats Dahlbom,	DMI Denmark	1
AlLe,	Alina Lerner,	ESTEA Estonia	5
ReEr, DaSch,	Reima Eresmaa, David Schönach,	FMI Finland	2
ErGr,	Erik Gregow,	FMI Finland/D	4
OlCo, OlGu,	Olivier Coopmann, Oliver Guillet,	Météo-France	8
AnKa, AnKa, DaLa,	Aniko Kardos-Varkonyi, Aniko Kardos-Varkonyi, David Lancz,	OMSZ Hungary	6
EoHa, EoWh,	Eoghan Harney, Eoin Whelan,	MET Eireann	1.75
FaHd,	FatimaZahra Hdidou,	Maroc Meteo	1
JaBa, SdH, SvdV,	Jan Barkmeijer, Siebren de Haan, Sibbo van der Veen,	KNMI Netherlands	3.5
StGu, PeDah, MaMi, JoBl, OlVi, RoAz,	Stephanie Guedj, Per Dahlgren, Mate Mile, Joisten Blyverket, Ole Vignes, Roohollah Azad,	MET Norway	3
MaMo,	Maria Monteiro,	IPMA Portugal	4
MaDe, MiNe,	Maria Derkova, Michal Nestiak,	SHMU Slovakia	4
BeSt,	Benedikt Strajnar,	ARSO Slovenia	1
JaSa, MaDi, CaGe, CaGe, JoPe,	Jana Sanchez, Maria Diez, Carlos Geijo, Carlos Geijo, Jose Miguel Perez,	AEMET Spain	11.5
MaLi, JeBo*,	Magnus Lindskog, Jelena Bojarova*,	SMHI Sweden	1.5
MaRi,	Martin Ridal,	SMHI Sweden/D	0.75
HaBe, WaKh,	Haythem Belghrissi, Wafa Khalfaoui,	INM Tunisia	3

WP objectives and priorities

Refine and optimize the system based on 3D-Var in several ways, with priority on adoption towards nowcasting:
- 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 spin-up in forecasts during first 1-2 h of model integration and due to imbalances caused by data assimilation procedure. Compare different background error statistics formulations (estimated using downscaling, EDA, Brand, with and without large scale mixing, with climatological and daily variation etc.) 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), and also by considering the variational constraint technique encoded in a non-hydrostatic model operator in building the balance between control variables in data assimilation.
- Explore data assimilation techniques and cycling strategies, suitable for nowcasting, for initialising cloud hydrometeors and winds (for example based on field-alignment for winds).
- 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.

Top priority tasks:
(1) Seek ways to further adopting system towards nowcasting by reduced spin-up and refined assimilation cycles.
(2) Tune the overall data assimilation system.
(3) Handling of model versus observations at different scales.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
DA1.1	**Tuning the assimilation scheme and making optimal use of observations taking the error characteristics and scale differences between observation and model into account (RT11, ST2-7):** evaluate scales of variability in mesoscale phenomena; investigate the effective model resolution, optimal scales for superobbing and meaningful scales for analysis updates, optimal scale for supermodding vs footprint operator; develop methodology to account for correlated observation errors, handling of gross errors, analysis and optimisation of error charecteristics as well as quality control rejection limits (first-guess check and VarQC, background errors in observation space) and to allow re-linearization. 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*)**	ReEr, DaSch, OlGu, EoWh, PeDah, MaMi, JoBl, JaSa, MaLi, HaBe, WaKh,	Code and scientific note		
DA1.2	**Assimilation cycling strategy (RT2, RT8):** evaluate aspects of assimilation setup with various assimilation schemes (3D, 4D, deterministic, nowcasting 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 (spatially and temporally) observations in case of 4D approach. Consider connection to hectometric scale DA. ***Also see SY 6.3.***	AlLe, DaLa, ErGr, ThMo, AnKa, EoHa, RoRa, MaMo, MaDe, MiNe, MaDi, JoPe, JeBo*,			
DA1.3	**B computation (ST8):** Assist the computation of appropriate background error statistics; Evaluate the impact of different formulations of the background error statistics (EDA, Brand, Forcing, LETKF) on the balance between control variables and on spinup.	AnSt, AlLe, AnKa, FaHd, RoAz, MaRi,	Scientific note		
DA1.4	**Large scale information (RT4):** 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.	ErGr, OlVi, MaDe,	Scientific note		

DA1.5	**Initialisation/spinup (RT2):** 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 also DA6.8 in connection with OOPS & EnVar); 5) *Digital filter initialisation (DFI):* assess the impact on reducing the spinup effect; 6) *Diagnostic tools:* Explore the use of DDH, ECHKEVO for estimating the observed spinup.	MaDa, AlLe, ErGr, DaSch, EoHa, JaBa, SdH, SvdV, MiNe, CaGe, JoPe,			
~~DA1.6~~	~~**Tracking of structure (RT3):** Implement HybridEnVar scheme based on tracking of structures for a very short forecast ranges (0-9h) base on the EPS and alpha control variables.~~	OlCo,			
DA1.6	**Observing system simulation experiments (ST2):** 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 Var.	OlCo,	Scientific note		
DA1.7	**Setup, maintenance and evolution of the state-of-art ACCORD [3D/4D-Var/BlendVar/3D/4DEnVar] assimilation cycles (ST2):** 1) Build an assimilation script system (if needed consider Harmonie, ***Olive*** and LACE examples); 2) Follow-on changes of e-suites, exchange about scientific achievements between ACCORD partners. 3) Maintenance and coordination of local operational and reanalysis script systems, and organise meetings to promote them.	NaAw, AnSt, StGu, MaMi, MaMo, MaDe, MiNe, BeSt,	Scientific note		

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
ReEr,	Reima Eresmaa,	FMI Finland	0.25
AnHu, CeLo, LoBe, PiBr, NiGi, OlGu, VaVo,	Antoine Hubans, Cecile Loo, Loik Berre, Pierre Brousseau, Nicole Girardot, Oliver Guillet, Valerie Vogt,	Météo-France	22.5
EoWh,	Eoin Whelan,	MET Eireann	1
JaBa, IsMo,	Jan Barkmeijer, Isabel Monteiro,	KNMI Netherlands	4.5
JaBa,	Jan Barkmeijer,	KNMI Netherlands/D	1
JoBl, RoSt, OlVi,	Joisten Blyverket, Roel Stappers, Ole Vignes,	MET Norway	2
JaSa, PaEs,	Jana Sanchez, Pau Escriba,	AEMET Spain	5
MaRi, DaYa, MaLi, RoSc, NiHa, MaRi*, JeBo*, SuHa*,	Martin Ridal, Daniel Yazgi, Magnus Lindskog, Ronald Scheirer, Nina Håkansson, Martin Ridal*, Jelena Bojarova*, Susanna Hagelin*,	SMHI Sweden	8.5
UlAn,	Ulf Andrae,	SMHI Sweden/D	0.75

WP objectives and priorities

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 2023 or 2024. 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. Several members plan for operational implementation of 4D-Var and there are some remaining further refinements and tuning of the system to be done. Adoptions towards OOPS will take place in DA6.

Top priority tasks:

(1) Refinements to 4D-Var,

(2) Perturbation techniques for EnVar and Hybrid Var/Ens methods.

(3) Work towds introducing elements of machine learning in various parts of the DA code.

(4) Long term activities towards coupled DA.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
DA2.1	**Towards operational implementation of 4D-Var (RT3):** 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.	ReEr, AnHu, CeLo, EoWh, JaBa, IsMo, OlVi, JaSa, PaEs, MaRi, MaLi, MaRi*, UlAn, JeBo*, SuHa*,	Code and scientific note		
DA2.2	**EDA and its use for EnVar in OOPS (RT1, ST8):** 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, PiBr, NiGi, OlGu, VaVo,	code and scientific notes		
DA2.3	**Ensemble initial perturbation (RT3):** 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*,	Code and scientific note		
DA2.4	**Partical filter (RT1, RT3):** 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.		code and scientific notes		
DA2.5	**LETKF (RT3):** 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	**Coupled DA (RT9):** Explore the possibilty of extending the control variables in EnVar scheme to support coupled atmospheric and surface data assimilation ***(see also SU1.9).***	JoBl, RoSt, ToLa*, JeBo*,			
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 (**RT2, RT8**).		code and scientific notes		
DA2.8	**Machine learning (RT12):** Explore machine learning approaches in data assimilation. ***Link with ML1.8.***	RoSc, NiHa,	Scientific note		
DA2.9	**Tracking of structure (RT3):** Implement HybridEnVar scheme based on tracking of structures for a very short forecast ranges (0-9h) base on the EPS and alpha control variables.				

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
GhCh, MOAM,	Ghiles Chemrouk, Mohand Ouali Ait Meziane,	ONM Algeria	4
FlWe, FlMe,	Florian Weidle, Florian Meier,	ZAMG Austria	4
AlDe, IdDe,	Alex Deckmyn, Idir Dehmous,	RMI Belgium	2.5
BoTs, MiTs, KoMl,	Boryana Tsenova, Milen Tsankov, Konstantin Mladenov,	NIMH Bulgaria	4
SuPa, AnSt,	Suzana Panežić, Antonio Stanešić,	DHMZ Croatia	6
AnBu, AlTr,	Antonín Bučánek, Alena Trojáková,	CHMI Czech	4.5
BjAm, MaDa,	Bjarne Amstrup, Mats Dahlbom,	DMI Denmark	4
ReEr, DaSch,	Reima Eresmaa, David Schönach,	FMI Finland	1
OlAu, MaBo, PhCh, NaFo, MaMa, PaMo, ChPa, ViPo, DoRa, SMW, ThMo,	Olivier Audouin, Mary Borderies, Philippe Chambon, Nadia Fourrie, Maud Martet, Patrick Moll, Christophe Payan, Vivien Pourret, Dominique Raspaud, XXX-satellites MW, Thibaut Montmerle,	Météo-France	41.25
ZsKo, HeKo, KrSz, AnKa,	Zsofia Kocsis, Helga Kollathne Toth, Kristof Szanyi, Aniko Kardos-Varkonyi,	OMSZ Hungary	8.5
SiTh,	Sigurður Thorsteinsson,	IMO Iceland	3
EoHa, EoWh,	Eoghan Harney, Eoin Whelan,	MET Eireann	1.75
ZaSa, ZaSa, FaHd,	Zahra Sahlaoui, Zahra Sahlaoui, FatimaZahra Hdidou,	Maroc Meteo	4
IsMo, SdH, SdH,	Isabel Monteiro, Siebren de Haan, Siebren de Haan,	KNMI Netherlands	4
MaSz,	Małgorzata Szczęch-Gajewska,	IMGW Poland	3
MaMo,	Maria Monteiro,	IPMA Portugal	0.5
AlDu,	Alina Dumitru,	Meteo Romania	1
MaDe, MaIm, MiNe,	Maria Derkova, Martin Imrisek, Michal Nestiak,	SHMU Slovakia	4.25
BeSt, PeSm, JuCe,	Benedikt Strajnar, Peter Smerkol, Jure Cedilnik,	ARSO Slovenia	5
JaSa, MaDi, JoPe, JoCa,	Jana Sanchez, Maria Diez, Jose Miguel Perez, Joan Campins,	AEMET Spain	8.5
MaRi, GuHa, SuHa*,	Martin Ridal, Gunther Haase, Susanna Hagelin*,	SMHI Sweden	3.5
MaRi,	Martin Ridal,	SMHI Sweden/D	1
HaBe, WaKh,	Haythem Belghrissi, Wafa Khalfaoui,	INM Tunisia	5
YeCe, MeSe, ErKü,	Yelis Cengiz, Meral Sezer, Ersin Küçükkaraca,	MGM Turkey	4

WP objectives and priorities

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 the potential to use these observations become available operationally to as many members as possible. Another important task is how to optimise the use for nowcasting purposes and here also assimilation methods and strategies (DA1 and DA2) are important. Important aspects for nowcasting are short latency and high temporal and spatial data density. Therefore data exchange of observations is one important aspect. With regard to Mode-S, data from the planned short-latency EMADDC stream should be investigated in the nowcasting systems. There is as well room for potential improvement of thinning procedures for Mode-S EHS.
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, cloud detection, the size of their footprint with respect to the modelled values, and bias correction. For radar data, quality control investigations and sharing of this information within the consortium will remain a point of attention. With regard to satellite instruments it is important to cooperate to use data from well knowns instruments on newly launched satellites as well as to continously refine the use of existing data from traditional instruments (i.e. improved bias correction, cloud-detection, footprint operator and handling of surface emissivities).
Top priorities:
(1) Assimilation of both radar reflectivities and winds.
(2) Exploit refined Mode-S EHS usage for nowcasting.
(3) Enhanced assimilation of existing satellite radiances.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
DA3.1	**Assist local implementation of radar data assimilation (RT13/ST5):** 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 processing 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.	IdDe, SuPa, MaDa, MaMa, KrSz, EoHa, MaSz, MaMo, MiNe, BeSt, PeSm, JaSa, MaRi, GuHa,	T-codes and scientific note		
DA3.2	**Observation from moving platforms (RT11, ST4):** 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 (See also **DA1.1** about correlated observation errors).	FlWe, AnSt, PaMo, ViPo, EoWh, SdH, MaDi,	T-codes and scientific note		

DA3.3	**Ground-based GNSS observations (RT7, RT13, ST5):** **-- further elaborate the assimilation of GNSS ZTD data:** 1) GNSS-ZTD from trains: quality control, thinning/super-obbing; work out and evaluate a VarBC solution; 2) assimilation of GNSS ZTD data without or with less anchoring observations; 3) refine white- or blacklisting of GNSS stations and use of VarBC; 4) conduct impact study; 5) assimilate GNSS ZTD in 4D-Var; 6) Space-based GNSS observations: new GNSS-RO Receivers **-- GNSS slant delay:** 7) further assist the implementation and porting process to the common code, conduct impact study with 3D/4D-Var; 8) test feasibility and impact of InSAR delay data from Sentinel-1 with slant delay operator; **-- GNSS ZTD horizontal gradients:** 9) Perform impact studies with data provided by IGN.	GhCh, MOAM, FIMe, IdDe, PaMo, DoRa, ThMo, FaHd, SdH, MaIm, JoPe, MaRi,	T-codes and scientific note		
DA3.4	**Scatterometer winds (RT11, ST6):** 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).	ChPa, IsMo,	T-codes and scientific note		
DA3.5	**Atmospheric Motion Vectors (AMV) (RT11, ST6):** Assist the implementation of both locally (NWCSAF HRW software) and EUMETSAT generated AMV's (geo and polar wind); elaborate the blacklisting procedure.	DaSch, ZsKo, HeKo, PeDah,	T-codes and scientific note		
DA3.6	**Clear-sky radiances (RT1, RT7, RT11, ST1, ST7):** 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 Sevir at large zenith angles.	BjAm, MaDa, ReEr, DaSch, OlAu, MaBo, PhCh, NaFo, SMW, ThMo, ZaSa, IsMo, StGu, MaMi, JoBl, MaDi, JoCa, SuHa*,	T-codes and scientific note		
DA3.7	**Assist local implementation of high-resolution ascent and decent radiosondes and wind profilers (ST3):** optimize local pre-processing, extend observation operator, assess the quality and perform impact study.	PaMo, AnKa, MaDe, JuCe, HaBe, WaKh, YeCe, MeSe, ErKü,	T-codes and scientific note.		
DA3.8	**Surface observations (Pressure, T2m, Hu2m, V10m) (RT11, ST1, ST2, ST3):** Address quality control and bias correction; Perform impact assessment; promote data exchange between NMS's.	MOAM, IdDe, BoTs, MiTs, KoMl, PaMo, MaMo, AlDu, MiNe, MaDi, HaBe, WaKh,	T-codes and scientific note		

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
MOAM,	Mohand Ouali Ait Meziane,	ONM Algeria	3
PhSc, FlMe, New1,	Phillip Scheffknecht, Florian Meier, Newcomer-ZAMG-1,	ZAMG Austria	10
IdDe,	Idir Dehmous,	RMI Belgium	3
BjAm, ClPe, KaHi, MaDa,	Bjarne Amstrup, Claus Petersen, Kasper Hintz , Mats Dahlbom ,	DMI Denmark	6.5
EmAh, KaHi,	Emy Ahlerskns , Kasper Hintz ,	DMI Denmark/D	4
ReEr, DaSch,	Reima Eresmaa, David Schönach,	FMI Finland	2.5
ErGr,	Erik Gregow,	FMI Finland/D	1
JeOt, OlAu, MaBo, TCB, PhCh, ECL, PaCo, NaFo, RhMn, MaMa, RoMa, JeOt, ViPo, LoRi, NiSa, EtVi, SMW, ClAu, ClDa, AlDe, ViFo, MaMd,	Jérémy Ottaviano, Olivier Audouin, Mary Borderies, Thomas Carrel-Billiard, Philippe Chambon, Elisa Chardon-Legrand, Pauline Combarnous, Nadia Fourrié, Rohit Mangla, Maud Martet, Robin Marty, Jérémy Ottaviano, Vivien Pourret, Louis Rivoire, Nicolas Sasso, Ethel Villeneuve, XXX-satellites MW, Clotilde Augros, Cloe David, Alan Demortier, Vincent Forcadell, Marc Mandement,	Météo-France	109.75
RóDa,	Rónán Darcy,	MET Eireann	0.5
ZaSa,	Zahra Sahlaoui,	Maroc Meteo	1
JaBa, GJMa, IsMo, SdH, CdB, SvdV, ,	Jan Barkmeijer, Gert-Jan Marseille, Isabel Monteiro, Siebren de Haan, Cisco de Bruijn, Sibbo van der Veen, Newcomer-KNMI-1,	KNMI Netherlands	9.5
SdH,	Siebren de Haan,	KNMI Netherlands/D	1
MiNe,	Michal Nestiak,	SHMU Slovakia	1
MaRi, SuHa, RoSc, NiHa, SuHa*, ToLa*,	Martin Ridal, Susanna Hagelin, Ronald Scheirer, Nina Håkansson, Susanna Hagelin*, Tomas Landelius*,	SMHI Sweden	10
MaRi,	Martin Ridal,	SMHI Sweden/D	1

WP objectives and priorities

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, products). These observations will be particularly important for 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.

Top priorities:
(1) Crowd-sourced observations;
(2) All-sky satellite data assimilation
(3) Exploration of new satellite products (MTG, EPS-NG, AWS).

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
DA4.1	**All-sky radiances (RT5, RT7):** 1) **Implement the use of all-sky radiances** starting with ATOVS and SSMI/S (ECMWF method) in CY46/48/49). 2) **Use the RTTOV-SCATT** radiative transfer model for the quality control of microwave radiances before assimilation in the AROME 3D-Var; 3) **Cloud-affected radiances (RT1, RT7, RT11, ST1, ST7):** Synergy between infra-red and micro-wave radiometers; 4) Test of **MSG VIS assimilation** operator within RTTOV and implementation of assimilation interface.	FlMe, New1, IdDe, BjAm, ClPe, ReEr, ErGr, DaSch, MaBo, PhCh, ECL, NaFo, EtVi, SMW, SvdV, NiHa, ToLa*,	Codes and scientific note		
DA4.2	**High-resolution surface observations (surface pressure, T2m, q2m, V10m) (RT7, RT11, RT12):** Further explore the potential of volunteered observations from crowdsourced, private weather sations, cars, and smartphones. Implement the machine learning technique to quality control these observations in the common T-code. Evaluation of the QC method from (Mandement and Caumont, 2020) for Netatmo data, evaluation of this data in the Arome-France DA system, mitigation with data from the French weather station network RADOME (this is part of the PhD work by Alan Demortier, due to finish by end of 2023).	KaHi, ViPo, RóDa, RoRa, MiNe, MaRi,	Codes and scientific note		
DA4.3	**Observation from moving platforms (RT11,ST4):** 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; 3) balloons from Strateole-2 field campaign.	JeOt, ViPo,			
DA4.6	**Future satellite instruments (RT5, RT7):** 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); 9) MTG-FCI (follow up and impoved Seviri)	MOAM, MaDa, DaSch, OlAu, TCB, PhCh, ECL, PaCo, NaFo, RhMn, MaMa, RoMa, LoRi, NiSa, EtVi, SMW, JaBa, GJMa, IsMo, SdH, , StGu, PeDah, MaMi, RoAz, MaRi, SuHa, RoSc, SuHa*,	Codes and scientific note		
DA4.7	Assimilate wind data from recreational hot-air balloon flights in HARMONIE-AROME **(RT11, ST4):**	CdB,	Code and Scientific note		

DA4.8	**Rain based observations (RT6):** 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 and/or Latent Heat Nudging); 2) *Radar-based rain rate:* explore the same approach for assimialtion of radar-based, measured or analysed rain rates (as done in Morocco).	PhSc, ZaSa,	Codes and Scien		
DA4.9	**New technique for assimilating radar data (RT13):** 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.	IdDe, MaMa, ClAu, ClDa,	scientific note		
DA4.10	**Cloud and precipiation related satellite and radar products:** Explore the enhanced use of present and next generations satellite cloud products for initialisation and initialisation using derived rafar based products.	IdDe, ClPe, ErGr, MaBo, PhCh, ECL, SvdV, NiHa, ToLa*,	scientific note		

ACCORD WorkPackage description : DA6

WP number	Name of WP
DA6	Participation in OOPS (RT1)
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
FlMe,	Florian Meier,	ZAMG Austria	3
DaSa,	Daniel Santos,	DMI Denmark	0.25
EtAr, LoBe, PiBr, GuTh, ArPu, VaVo, NiMe,	Etienne Arbogast, Loik Berre, Pierre Brousseau, Guillaume Thomas, Argan Purcell, Valerie Vogt, Nicolas Merlet,	Météo-France	30.75
JaBa,	Jan Barkmeijer,	KNMI Netherlands	1.5
BeSt,	Benedikt Strajnar,	ARSO Slovenia	1
BeSt,	Benedikt Strajnar,	ARSO Slovenia/D	1
PaEs,	Pau Escriba,	AEMET Spain	2
PaMe, MaLi, JeBo*,	Paulo Medeiros, Magnus Lindskog, Jelena Bojarova*,	SMHI Sweden	3.5

WP objectives and priorities

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.
Top priorities:
(1) OOPS 3D-VAR assimilation with all observations that are used in MASTERODB version.
(2) OOPS EnVar,
(3) 4D-Var in OOPS

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
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.	DaSa, EtAr, LoBe, VaVo,	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, VaVo, PaMe,	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, VaVo, JaBa, RoSt,	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, VaVo, BeSt,	non t-codes		
DA6.5	Full-POS for OOPS & use of the new configuration "903"		t-codes		
DA6.6	Specific ARPEGE/LAM issues for re-factoring (DDH, LBC)		t-codes		
DA6.7	Digital filter initialization; Incremental Analysis Update (IAU) in OOPS	EtAr, VaVo,	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, VC, nudging), update with respect to refactored IFS Cycles, assess scalability and optimization. Cloud, hydrometeors and non-hydrostatic variables in control vector and B.	FlMe, EtAr, LoBe, PiBr, GuTh, ArPu, VaVo, RoSt, RoAz, NN, CaGe,	t-codes,non t-codes		
DA6.9	Other components or approaches : develop large scale error constraint ; allow centred FGAT ; LAM 4DVAR and HYBRID ENS/VAR; LETKF scheme. Find flexible technical solutions for consistent ensemble variational DA/EPS schemes.	JaBa, PaEs, DaYa, MaLi, JeBo*,	t-codes,non-tcodes		
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).	DaSa, EtAr, LoBe, VaVo,	minutes of meetings		

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
GhCh, MOAM,	Ghiles Chemrouk, Mohand Ouali Ait Meziane,	ONM Algeria	5
IdDe,	Idir Dehmous,	RMI Belgium	1
AnSt,	Antonio Stanešić,	DHMZ Croatia	1
AlTr,	Alena Trojáková,	CHMI Czech	4
BjAm,	Bjarne Amstrup ,	DMI Denmark	1
AhMe, AlLe,	Ahto Mets, Alina Lerner,	ESTEA Estonia	3
ReEr, DaSch,	Reima Eresmaa, David Schönach,	FMI Finland	1.25
FrGu, StMa, DoRa,	Frank Guillaume, Stéphane Martinez, Dominique Raspaud,	Météo-France	18.5
HeKo,	Helga Kollathne Toth,	OMSZ Hungary	1.25
SiTh,	Sigurður Thorsteinsson,	IMO Iceland	0.5
EoWh, EoWh, EoWh, EoWh, RóDa,	Eoin Whelan, Eoin Whelan, Eoin Whelan, Eoin Whelan, Rónán Darcy,	MET Eireann	2.5
ZaSa, ZaSa, FaHd, FaHd,	Zahra Sahlaoui, Zahra Sahlaoui, FatimaZahra Hdidou, FatimaZahra Hdidou	Maroc Meteo	8
JaBa, Ismo,	Jan Barkmeijer, Isabel Monteiro,	KNMI Netherlands	2
MaTh,	Manuel Theriaga,	IPMA Portugal	0.25
NN1, BeSt,	newcomerARSO1, Benedikt Strajnar,	ARSO Slovenia/D	2
MaDi, JoCa,	Maria Diez, Joan Campins,	AEMET Spain	2
PaMe,	Paulo Medeiros,	SMHI Sweden	1
YeCe, MuSe,	Yelis Cengiz, Mustafa Sert,	MGM Turkey	3

WP objectives and priorities

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. Some first ideas of automatic detection of bad observation quality will be explored.
- Diagnostics, like ECHKEVO and DDH, useful for nowcasting needs to be further exploited.
- 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.

Top priorities:
1. DA7.3 Maintenance/development of ODB software - Bator/ObsConvert/COPE - is critical for operations and is also usually the first step for use-of-observation research.
2. DA7.2 Diagnostic tools. A lot of common ground here for the CSCs to cooperate on.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
DA7.1	**COPE (ST2):** Re-evaluate COPE with SAPP BUFR and CY46 and report on its potential, in particular address requirements for observations not currently assimilated by ECMWF : replace QC filters from the pre-processing software; implement local data formats (radar, Mode-S, BUFR, ASCII) and functionalities (HDF reader, Lambert projection, report destruction); development of common blacklisting software; evaluate functionality a new prototype pre-processing system.	EoWh,	T-Codes and non-T-codes		
DA7.2	**Diagnostic tools (RT10, ST9):** 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.	GhCh, MOAM, AnSt, BjAm, AhMe, AlLe, ReEr, DaSch, DoRa, EoWh, ZaSa, FaHd, JaBa, Ismo, , MaDi, JoCa, PaMe, YeCe,	non-T-codes report		
DA7.3	**Implementation, maintenance and development of ODB software (ST2-7):** Basic extraction tools from the raw observations to ODB (bator, b2o, ObsConvert). Share knowledge on observation quality, observation errors, and blacklisting decision. 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.	GhCh, MOAM, StMa, EoWh,	non-T-codes		

DA7.4	**Pre-processing tools (ST2):** 1) SAPP: Assist the local implementation of SAPP for local observations pre-processing with special focus on observations not yet handled by the package. 2) Acquisition and pre-processing of GTS and non-GTS observations ensuring that duplications are removed from the data sample, and, if appropriate, consider a basic quality control (completeness, …). Where appropriate, consider conversion to Bator/ObsConvert-compatible format.	GhCh, MOAM, FrGu, RóDa, ZaSa, FaHd, MaTh, NN1, BeSt, MaDi, JoCa, MuSe,	non-T-codes		
DA7.5	**OPLACE (ST3-7):** 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.	GhCh, MOAM, HeKo,	non-T-codes, report		
DA7.6	**Coordination (ST3-7):** Communication and coordination of transversal questions (e.g. development of Bator, ObsConvert, and b2o)	EoWh,			

ACCORD WorkPackage description : PH1

WP number	Name of WP
PH1	**Turbulence & shallow convection**
WP main editor	**Eric Bazile, Wim de Rooij, Mario Hrastinski**

Table of participants

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

Participant Abbreviation	Participant	Institute	PersonMonth
SaChi,	Sara Chikhi,	ONM Algeria	2
FlMe,	Florian Meier,	ZAMG Austria/D	1
MaTu,	Martina Tudor,	DHMZ Croatia	0.5
MaHr,	Mario Hrastinski,	DHMZ Croatia/D	4
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech	5.5
ErBa, YvBo, RaHo, JMP, YaSe, DiRi, AdMa, SeRi,	Eric Bazile, Yves Bouteloup, Rachel Honnert, Jean-Marcel Piriou, Yann Seity, Didier Ricard, Adrien Marcel, Sebastien Riette,	Météo-France	26.5
SiSb, NcMo1,	Siham Sbii, NewcomerMorocco1,	Maroc Meteo	6
NaTh, WdR,	Natalie Theeuwes, Wim de Rooij,	KNMI Netherlands	5
BjEn, TeVa, MaKa,	Bjorg Jenny Engdahl, Teresa Remes, Marvin Kahnert,	MET Norway	0.5
PeSm,	Peter Smerkol,	ARSO Slovenia	4
MeSh,	Metodija Shapkalijevski,	SMHI Sweden	1

The intention is to foster thematical collaboration across ACCORD and across CSC teams, in the area of Physics pamaretrizations. Besides the ongoing development plans in the three CSCs, we intend to organize scientific exchanges (ideas, results, experiences, shared reporting) and an increased topical-wise animation (in the form of regular videomeetings, or a common workshop). On the shorter term we can learn and be inspired from each other work on the same parameterizations due to the new set-up of the RWP. On the (very) long term there can be a natural tendency of parameterization convergence due to the increasing resolution. Shallow convection schemes will ultimately be become obsolete and the turbulence schemes of the different CSCs mainly differ in their description of the large eddy's that will ultimately become resolved.

A substantial part of the foreseen work on turbulence and convection is related to (very) high resolution runs and the grey zone:

Work (for the shorter term or a bit longer) on more pragmatic adaptation for the turbulence and shallow convection for running the CSC at 500m or less by modifying mixing length and a more scale aware mass flux for shallow convection. Note that a scale-aware convection scheme might already be beneficial at current operational resolutions (between approx. 500m and 2.5km)

About the path towards 3D effects in turbulence, hereafter we recall the outcomes of the side meeting discussion at the 2022 ASW:
* the short/mid-term plans seem clear: implement and validate quasi-3D formulations, study the Goger etal. approach (in mountaineous areas), study the Moeng etal. approach (for strong convection clouds)
* towards "full 3D turbulence"(longer term):
  - focus on what observations can teach us and what other have already done, make bibliography survey on what other academics have done regarding scale analysis
  - full 3D turbulence requires to compute the horizontal divergence of horizontal fluxes, and it is important to first understand which of these terms really matter (cf scale analysis outcome)
  - from the code point of view, we probably have all the relevant infrastructure for 3D turbulence, or we know how to code what's missing
  - addressing the 3D effects of turbulence with SLHD (PH1.3).

HARMONIE-AROME: There will be remaining attention on current model weaknesses such as too weakly precipitating cold outbreak convection and missing convection in weak dynamic forcing situations. Also stochastic physics (PH10) and ML in this area is under consideration. Many of the developments are related to adapting/changing the turbulence and convection scheme for (very) high resolutions.

ALARO: Developments of the TOUCANS turbulence scheme will continue with priorities in three main directions: i) finalization of the baseline version of the TKE-based mixing length formulation and its further upgrade (PH1.1), ii) revision of TOMs parameterization (PH1.2) and iii) addressing the 3D turbulence efects (PH1.3 - ALARO specific development and PH1.8 - common work with other CSCs).

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
PH1.1	**TKE-based mixing length (ML) formulation in TOUCANS scheme:** Recently found scaling issue will be fixed, and the impact of buoyancy-shear formulation (BSF) in the 3D model reevaluated. Unnecessary tuning degrees of freedom will be removed. Since all ML formulations within TOUCANS strongly depend on PBL height diagnostics, part of the task will be to implement and validate a more robust method that utilizes Bougeault-Lacarrère upward displacements following Bašták Ďurán et al. (2022.). The upper-air asymptotic behavior of the BSF will be adapted according to atmospheric conditions to represent the top PBL entrainment. To include the impact of moisture in the BSF calculation, we will consider the motion of two parcels in different environments determined by cloud fraction, stratification and turbulence characteristics.	SaChi, MaHr, ErBa, YvBo, JMP, SiSb, NcMo1, NaTh, WdR,	doc, papers, t-code	IAL	
PH1.2	**Revision of TOMs parameterization in TOUCANS scheme:** Starting from the most simple configuration, we will apply all the fixes found previously, and inspect whether TOMs can produce no-gradient and counter-gradient scalar transport. If not, the complexity of TOMs implementation can be gradually increased and validated.	PeSm,	doc, t-code	IAL	
PH1.3	**Addressing the 3D effects within TOUCANS scheme:** Link horizontal turbulence length scale (HTLS) to vertical by utilizing the anisotropy information provided by TOUCANS and/or implement other HTLS options available in the literature. In the following step, the selected HTLS option will be utilized within the 3D approach (1D+2D; mixing also in the horizontal direction), based on the infrastructure developed in the SLHD environment.	MaHr,	doc, t-code		
PH1.4	Investigate the strength and weaknesses of VHR output by evaluation and comparing daily 500m and 200m resolution 3D runs by making use of sophisticated observations (including satellite), daily LES runs, 1D runs and operational 3D model output.	NaTh, WdR,	doc, papers, t-code		
PH1.5	Continue to explore options for improving the model representation of open cell convection. In this problem the influence of microphysics (PH3) , shallow convection, turbulent mixing, and evaporation over the sea will be investigated. 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). Not only for open cell convection but more in general meso-scale organisation iin HARMONIE-AROME is studied within the EUREC4A project (link to PH3.9)	AdMa, SeRi, NaTh, WdR, BjEn, TeVa, MaKa, JaCa, MeSh,			
PH1.6	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,			
PH1.7	Part of the 3D effects by Increasing the mixing into the cumulus deep clouds by adding turbulence terms from **Moeng et al. (2010)**. See also Verrelle et al. (2015)	ErBa, RaHo, YaSe, DiRi,			
PH1.8	**Goger et al. (2019)** 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 (3D) in the shear production term. After complete validation of the code in CY48, resume the impact study of this term with the TKE scheme in AROME and TKE+TTE scheme in ALARO	MaHr, RaHo, YaSe,	The needed code is in CY48T2 (fixed version). Studies started.		
PH1.9	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,			
PH1.12	For a more pragmatic adaptation (shorter term) for resolutions in the the grey zone, several ideas will be be studied accross the CSC: scale-aware turbulence length scale, scale aware shallow convection both following ideas of RaHo	NaTh, WdR,			

ACCORD WorkPackage description : PH2

WP number	Name of WP
PH2	Radiation
WP main editor	Eric Bazile, Emily Gleeson, Ján Mašek

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
KrNi, PeUk,	Kristian Pagh Nielsen , Peter Ukkonen,	DMI Denmark	11
LaRo,	Laura Rontu,	FMI Finland	2
QuLi,	Quentin Libois,	Météo-France	0.5
GNPe,	Guðrún Nína Petersen,	IMO Iceland	1
EmGl,	Emily Gleeson,	MET Eireann	1
DaMa,	Daniel Martin,	AEMET Spain	1

WP objectives and priorities

The intention is to foster a thematical collaboration across ACCORD and across CSC teams, in the area of Physics pamaretrizations. Besides the ongoing development plans in the three CSCs, we intend to organize scientific exchanges (of ideas, results, experiences and shared reporting) and increased interaction on topics (in the form of regular videomeetings, or a common workshop).

HARMONIE-AROME: A thorough evaluation of the ecRad radiation scheme and comparison to the current default IFSradia. Work will be done to improve the realism of the radiation schemes and the interaction between radiation and clouds and/or aerosol (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 will be investigated, such as the grid spacing to use for radiation as we move to higher resolution, ML to speed up calculations, accounting for 3D effects etc.

ALARO: The focus is put on interfacing of ACRANEB2 radiation scheme with near real time aerosols, plus externalization of cloud effective radii. These points are addressed within workpackage PH6. Apart from that, minor improvements of ACRANEB2 scheme are planned: interfacing and testing of single precision version in 3D model, inclusion of CFC-11 and CFC-12 in CO2+ composite, impact of clouds on the broadband surface albedo. Future revision of gaseous transmissions is possible. There is currently no idea how to accommodate 3D effects in ACRANEB2. GPU refactoring issues will be solved during preparation of APL_ALARO. Plugging of ecRad in APL_ALARO is also considered.

AROME and ARPEGE: ECRAD will be further tested for an operational use in ARPEGE in 2023.

At the side meeting of the ASW2022 about **3D effects in physics**, the following workplan had been outlined:
- evaluate a poor man's solution (TICA) for taking into account some 3D effects, however we could perhaps aim for a more ambitious and valuable plan (see next bullets)
- develop a coarse grid approach with SPARTACUS, the 3D solver that comes with ECRAD: (1) study the IFS code solution and draft specs for LAM; (2) implement the call to SPARTACUS in LAM; (3) use fine grid fields for cloud overlap, effective cloud edge length, cloud optical saturation
- first steps should be to form a task team to further discuss this work plan, evaluate the manpower needs for its realization and start assessing its possible staffing (it was noted that ACCORD might need an ECRAD expert of its own)

These ideas are reflected in task PH2.7 below.

CLOUD - AEROSOL - RADIATION INTERACTIONS (moved from PH6)
Externalisation of aerosol and cloud particle input processing from inside the radiation schemes to APL_AROME/APLPAR level is to be finalized. Variables concerned are the aerosol runtime optical properties and cloud particle mass, number concentration and effective size. The effective/equivalent radii of cloud particles for the radiation schemes should be calculated from the cloud particle distributions that are estimated by the microphysics parametrizations. Radiation schemes will be adapted to use cloud particle sizes as input instead of diagnosing them internally. For ascending compatibility, the present internal diagnostics alternatives will have to be kept under logical key in a separate subroutine called from APLPAR/APL_AROME.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
PH2.1	Interfacing of ACRANEB2 single precision version with 3D model and testing the impact. Inclusion of CFC-11 and CFC-12 in CO2+ composite. Introduction of separate SW and LW CO2+ scaling factors, useful in climate mode. Plugging ECRAD in APL_ALARO.	PeUk,	t-code, new CO2+ fits	IAL	12/2023
PH2.2	Complete the work on achieving a consistent use of particle properties across microphysics, cloud and radiation schemes: Import the effective sizes of cloud ice, cloud liquid, graupel, snow and rain particles from microphysics to the radiation schemes. For ascending compatibility, the present particle size diagnostics internal to radiation schemes will have to be kept under logical key in a separate subroutine called from APLPAR/APL_AROME.	KrNi, LaRo, QuLi,			
PH2.3	Externalise the effective radius calculations from inside the radiation schemes; develop, recode and test within MUSC cy46. This is connected to **PH6**.	EmGl, DaMa,			
PH2.4	Explore the possibility of deriving cloud cover from the subgrid fractions and the optical depth of each water species.				
PH2.5	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 its performance.	GNPe, EmGl,			
PH2.6	Consider the need for further tuning for the acraneb2 scheme when applied within HARMONIE-AROME. Check that ACRANEB2 is handled correctly in HARMONIE-AROME with default and NRT aerosols (**PH6** also)	LaRo, DaMa,			
PH2.7	Intercomparison of the hlradia, acraneb2 and ifsradia and ECRAD radiation schemes (connected to **PH6**), also with a view to their potential use as multiphysics options in HarmonEPS.	LaRo, GNPe, EmGl,			
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.	KrNi,			

PH2.9	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 use in MF's NWP systems for 2023				
PH2.10	Continue the exploration of the potential of ML tools for radiation, mostly in combination with ECRAD and its components (optical properties, 3D solver emulation). Contacts on these topics with ECMWF.	PeUk,			
PH2.11	**3D effects of radiation**: Develop a coarse grid approach with SPARTACUS, the 3D solver that comes with ECRAD: (1) study the IFS code solution and draft specs for LAM; (2) implement the call to SPARTACUS in LAM; (3) use fine grid fields for cloud overlap, effective cloud edge length, cloud optical saturation (4) application of ML for computation affortability purposes. See also **HR1.4**	PeUk,			
PH2.12	Cloud-aerosol-radiation interaction (moved from PH6)				

ACCORD WorkPackage description : PH3

WP number	Name of WP
PH3	Microphysics and clouds
WP main editor	**Martina Tudor, Bogdan Bochenek, Emily Gleeson, Yann Seity**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
AbAm, MoMo,	Abdenour Ambar, Mohamed Mokhtari,	ONM Algeria	3
ClWa,	Clemens Wastl,	ZAMG Austria	1
LuGe,	Luc Gerard,	RMI Belgium	4.5
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
DaNe,	David Němec,	CHMI Czech	6
PeUk,	Peter Ukkonen,	DMI Denmark	1
PaMa,	Panu Maalampi,	FMI Finland	2
SeRi, MJW, ReDu, BeVi,	Sebastien Riette, Mareva July Wormit, Rémi Dupont, Benoit Vie,	Météo-France	32
EmGl, EwMcA,	Emily Gleeson, Ewa McAufield,	MET Eireann	3
KaKa,	Kamal Karouni,	Maroc Meteo	2
WdR, SeCo,	Wim de Rooij, Sebastian Contreras,	KNMI Netherlands	9
BjEn, TeVa, MaKa, OsLa,	Bjorg Jenny Engdahl, Teresa Remes, Marvin Kahnert, Oskar Landgren,	MET Norway	1.5
PiSe,	Piotr Sekuła,	IMGW Poland	1
DaMa,	Daniel Martin,	AEMET Spain	3
MeSh, KIlv,	Metodija Shapkalijevski, Karl-Ivar Ivarsson,	SMHI Sweden	1.75
HaDh, RaBR,	Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	6

WP objectives and priorities

The intention is to foster thematical collaboration across ACCORD and across CSC teams, in the area of Physics pamaretrizations. Besides the ongoing development plans in the three CSCs, we intend to organize scientific exchanges (ideas, results, experiences, shared reporting) and an increased topical-wise animation (in the form of regular videomeetings, or a common workshop).

ALARO: Focus is on improvement of processes of autoconversion, collection, evaporation and melting, all of them using prognostic graupel. Comparisons are made with solutions in other microphysics packages: ICE3, WSM6, Thomson, COSMO, UM. Impact of improvements in vertical geometry will be evaluated. Inclusion of n.r.t. aerosols in APLMPHYS is considered.

HARMONIE-AROME: A focus on improving the general forecasting of clouds and microphysics (phase, condensate, cloud base etc) including thoroughly evaluating compared to satellite data, CLOUDNET and Copernicus data and using the KNMI cloud simulator in order to identify systematic biases that can be improved upon. A comparison of the ICE3 scheme to LIMA and also thorough testing and evaluation of ICE-T in CY46. This work will also be carried out in relation to near real-time aerosols - the impact on the development of clouds and precipitation. Fog forecasting improvements is still a high priority especially in the context of LIMA, nrt aerosols and other microphysics tunings being considered.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	Code contrib to repository	Expected delivery (MM/YY)
PH3.1	Cloudiness parametrisation utilizes prognostic condensates and water vapour - Cloud scheme, shallow convection cloudiness	ClWa, LuGe, PeUk, PaMa, SeRi, BeVi, EmGl, KaKa, SeCo, DaMa,			
PH3.2	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. Non-saturated downdraught and Complementary Subgrid Drafts (CSD)	LuGe, SeRi, WdR,			
PH3.3	ALARO microphysics (APLMPHYS) – prognostic graupel is coded and phased in the common code. Testing and tuning work is ongoing. **Further work:** Improvement of processes and vertical geometry, study of their feedback. Analysis of aerosol introduction.				
PH3.4	Test the behaviour of LIMA in HARMONIE-AROME. Possible extension and testing of Thompson microphysics scheme in the LIMA framework. New developments in LIMA (Full 2 moments, 2moments only for warm clouds, merge with ICE3).	MJW, ReDu, BeVi, EmGl, EwMcA, SeCo, BjEn, DaMa, MeSh, KIlv,			
PH3.5	Thorough comparison/evaluation of the ICE3 and LIMA schemes	AbAm, MoMo, MJW, ReDu, BeVi, EmGl, SeCo, TeVa, DaMa, HaDh, RaBR,			
PH3.6	Implement ICE-T as an operational switch in CY46 of HARMONIE-AROME. Further testing of ICE-T for a range of case studies.	BjEn,			
PH3.7	Investigate the representation of Arctic clouds and microphysical processes in, among others, AROME-Arctic. A novel dataset off the coast of Norway, collected by flying through clouds with a research aircraft, will be used to validate microphysical processes in the model	SeRi, BjEn, TeVa, MaKa,			
PH3.8	Explore the behaviour of precipitation at the lateral boundaries (nesting problems).	OsLa,			
PH3.9	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.	SeCo, DaMa,			
PH3.10	Testing the cloud droplet size distribution - sensitivity of parameters in relation to fog etc, use of observations to define the profiles. A continuation of the work started in the MDPI Atmosphere fog-related paper by SeCO et al. Include study of impact of NRT aerosol and the manner of activation of aerosols in this work.	PaMa, EmGl, SeCo, DaMa,			
PH3.11	Exploration of ML-based formulation of liquid cloud optics	PeUk,			
PH3.12	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.				

PH3.13	Add fog deposition term in ICE3				
PH3.14	Study the influence of vertical resolution on decoupling in SBL and fog formation				
PH3.15	Study the impact of (LIMA) cloud microphysics in relation to fog	BeVi, KaKa,			
PH3.16	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.	SeCo, DaMa,			
PH3.17	Further improve ICE3/ICE4 especially with respect to forecast of hail	ClWa,			
PH3.18	SOFOG field experiement : sub grid condensation (partial cloud cover) in LIMA.				
PH3.19	Cold microphysics intercomparison exercice (1D MPACE case ?)				
PH3.20	Technical aspects (Code adaptation to GPU, externalisation of MésoNH physics, Toward uniformisation of rain-ice versions)	SeRi,			
PH3.21	New developments in ICE3 (Use of Nc for autoconversion, pdf harmonisation)	SeRi,			
PH3.22	**Development statistical cloud scheme**. From the ARM shallow cumulus case, and confirmed by EUREC4A results, we know that cloud cover in the upper part of convective cloud layers is underestimated in HARMONIE-AROME. In de Rooy et al. 2022, GMD a detailed analysis is provided which shows that this is caused by the lack of variance as used by the cloud scheme. Preliminary results with MUSC reveal that these problems can be solved with a new formulation of the convection time scale. The new formulation is physically plausible but LES runs will be used for further substantiation. Hereafter, long term verification (including EUREC4A) is necessary before operational implementation	WdR,			

ACCORD WorkPackage description : PH4

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
ErBa,	Eric Bazile,	Météo-France	1.5
EmGl,	Emily Gleeson,	MET Eireann	1
WdR,	Wim de Rooij,	KNMI Netherlands	0.5

WP objectives and priorities

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 beta version of the common (between the 3 CSC) MUSC version based on cy46t1 have been created during the Working Week in 2021 and validated at least for some cases for the 3CSC without SURFEX, however some works needs to be done for ALARO and SURFEX. The visualization tool EMS developped by R. Roerhig is now available. A continuation effort shoud be done in 2023 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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
PH4.1	Establish, maintain and upgrade “common MUSC” system	ErBa, PiSe,			
PH4.2	Create and add (idealized) test cases	EmGl, WdR,			
PH4.3	MUSC and EMS training and working days	EmGl, WdR,			
PH4.4	MUSC used for testing "the possible refactoring" of aplar and apl_arome linked with PH9.8				
PH4.5	Set up for daily MUSC runs	WdR,			

ACCORD WorkPackage description : PH5

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

Table of participants

This list of participants contains names provided in 2020-2022 by the LTMs. The list will probably have to be reviewed as the thematic groups are being formed. Not all names have an associated manpower commitment for now.

Participant Abbreviation	Participant	Institute	PersonMonth
BeZa, BaAb, WaCh,	Benghabrit Zakaria, Bahlouli Abdelhak, Walid Chikhi,	ONM Algeria	11
ChWi,	Christoph Wittmann,	ZAMG Austria	0.5
BoTs, MiTs, KoMl,	Boryana Tsenova, Milen Tsankov, Konstantin Mladenov,	NIMH Bulgaria	3
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
ClPe,	Claus Petersen ,	DMI Denmark	1
AhMe, IvAn,	Ahto Mets, Ivar Ansper,	ESTEA Estonia/D	1.5
InEt, OlJa, JMP,	Ingrid Etchevers, Olivier Jaron, Jean-Marcel Piriou,	Météo-France	7.5
NaMa, KaKa,	Najlae Marass, Kamal Karouni,	Maroc Meteo	4
MaDe, AnSi,	Maria Derkova, Andre Simon,	SHMU Slovakia	1.25

WP objectives and priorities

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 whether these model outputs could/should be considered for computation during the model runtime (if they require specific model fields) or 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).

As an outcome of the 2021 inquiry (aka PH5-questionnaire), the model output fields have been grouped into four categories for which we intend, at ACCORD level, to build more synergy across teams. Various needs for postprocessing fields (for traffic, energy or tourist/sport sectors) can be assigned to a task depending on the category of the required output. The intention is to organize dedicated meetings per category, so that the teams involved in each can exchange about their plans, and transversal collaboration per thematic can be encouraged. Another 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).

Specific postprocessing related to ensemble forecasts is addressed in EPS packages, the same for DA etc.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
PH5.1	Organisation of PH5-thematic meetings with a strong emphasis on the four main categories identified by the questionnaire in 2022. Discussion and drafting of work plans with the teams involved in those categories.	MaDe,	minutes from these meetings		
PH5.2	**Visibility, radiation, low clouds & fog.** Includes any specific development for energy, traffic, **etc.** 1. Development and implementation in a local code version (note: the phasing work to prepare a corresponding code contribution for a T-cycle may be referenced under the **COM2.1.3** task) 2. Improvement, tuning and validation, possibly in link with **MQA2** (if new methods or metrics for validation are being developed) 3. Adapting these diagnostic fields from one CSC to another.	WaCh, InEt, OlJa, NaMa, AnSi,	meeting in 2022 or early 2023; work plan proposal	IAL	tbd
PH5.3	**Convection-related (helicity, hail, lightning).** Same items 1-2-3 as in **PH5.2**	BaAb, ChWi, BoTs, MiTs, KoMl, InEt, OlJa, JMP, KaKa,	meeting in 2022 or early 2023; work plan proposal	IAL	tbd
PH5.4	**Precipitation types and their impact on surface conditions.** Same items 1-2-3 as in **PH5.2**	WaCh, AhMe, IvAn, InEt,	meeting in 2022 or early 2023; work plan proposal	IAL	tbd
PH5.5	**VHR turbulence-related (wind shear, gusts, EDR etc.).** Same items 1-2-3 as in **PH5.2**	BeZa, OlJa,	meeting in 2022 or early 2023; work plan proposal	IAL	tbd
PH5.6	Improvements, tuning and validation of ***existing or new*** model output postprocessing/diagnostic fields, ***not falling into any of the above categories***. Concrete examples could be: - aviation-related diagnostics not falling into VHR-turbulence - energy sector related not falling under visibility-clouds-fog or VHR turbulence (UV index ?, photovoltaic power index ?)	OlJa,	reporting via the ACCORD newsletter is highly encouraged		

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, Yann Seity**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MoMo, MoMo, AbAm,	Mohamed Mokhtari, Mohamed Mokhtari, Abdenour Ambar,	ONM Algeria	6
AnSl, MaTu,	Ana Šljivić, Martina Tudor,	DHMZ Croatia	3
JaMa,	Ján Mašek,	CHMI Czech	1
LaRo,	Laura Rontu,	FMI Finland	5
ViGu, JoGu,	Vincent Guidard, Jonathan Guth,	Météo-France	1
EmGl,	Emily Gleeson,	MET Eireann	1
PiSe,	Piotr Sekuła,	IMGW Poland	2
DaMa,	Daniel Martin,	AEMET Spain	1
KIIv,	Karl-Ivar Ivarsson,	SMHI Sweden	1
HaDh, RaBR,	Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	2

WP objectives and priorities

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 infrastracture 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 are done for 1+1 or 6+6 spectral divisions that covers the assumed radiation schemes. For backward compatibility and transition from AOD to MMR input, the new routines diagnose AOD550 for the 6 default Tegen species from MMRs. This makes it possible to use the default IFSRADIA (of cy25) and ACRANEB2 without modifications. **Radiation schemes have to be adapted so that they rely on externally specified values for the resulting aerosol mixture. HLRADIA scheme in h-codes is ready for this, but requires checking and improvements. The highest priority task is the adaptation of ACRANEB2. The present default IFSRADIA (of cy25) may also be updated, if considered necessary, while ECRAD is already internally adapted to CAMS aerosol use.**

PH6.4. INTERFACING NEAR REAL TIME AEROSOLS WITH CLOUD MICROPHYSICS .
Cloud-precipitation microphysics needs cloud condensation nuclei (CCN) and ice forming nuclei (IFN) concentration numbers. Concentration number of each CAMS aerosol type is obtained from its MMR, using assumed size distribution. For ICE3, this is done by a new subroutine called from APLPAR/APL_AROME. Only these two fields are passed deeper to microphysics. In LIMA microphysics, CCN and IFN are 'consumed' by the scheme, so that we will have to put back some LIMA tendencies into aerosols MMRs available in APL_AROME. **Consistency between ICE3 and LIMA aerosol definitions and usage needs to be ensured, anticipating their potential later use also for ALARO microphysics.**

PH6.5. VALIDATION AND TESTING.
Ascending compatibility of CAR developments will be evaluated thoroughly, verifying meteorological reproducibility of previous configurations. New CAR elements will be evaluated using extensive model-observation intercomparisons for biomass burning, mineral dust intrusion, anthrophogenic and volcanic emission case studies will be carried out, in order to evaluate aerosol impact on local weather. Direct aerosol effects can be evaluated with different radiation schemes, preferably using the more advanced ones.

Anticipated t-code deliverables within cy46/[cy48]:
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.
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). The method must be compatible with all spectral divisions used in considered radiation schemes.
4. Interfacing ACRANEB2 with the externalized optical properties of aerosol mixture. Possible introduction of these AOPs to IFSRADIA and later possible modifications of ECRAD.
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.
7. Subroutine containing existing and suggested new parametrizations of cloud particle effective size for input to radiative transfer calculations.
8. Introduction of aerosol-capable HLRADIA parametrizations to the common code (not intended for operational use).

Anticipated non-t-code deliverables:
1. Maintenance of the externalized gl in a repository open to the whole consortium.
2. HARMONIE-MUSC setup for forecast model code development and testing
3. Harmonie scripts and utilities for namelist generation to be available in an open repository

Note: It is planned to separate APLPAR and APL_AROME into five separate aplpar_phy routines for ARPEGE_nwp, ARPEGE_climate, ALARO, AROME and HARMONIE-AROME to allow cleaning. The data flow of aerosol related variables should be treated in task PH9.8 and also PH9.4. Possible computations and initializations will be moved from APLPAR* routines to other subroutines.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	Code contrib to repository (About code deliverables (if any))	Expected delivery (MM/YY) (About code deliverables (if any))
PH6.1	IMPLEMENTING DATA FLOW OF NEAR REAL TIME (n.r.t.) AND CLIMATOLOGICAL AEROSOLS.	LaRo, DaMa,	t-code		
PH6.2	AEROSOL CODE CONVERGENCE IN CLIMATE GENERATION AND FORECAST MODEL	LaRo,	report		
PH6.3	PREPARATION OF REAL-TIME AEROSOL OPTICAL PROPERTIES FOR THE RADIATION SCHEMES	AnSl, LaRo,	t-code		
PH6.4	INTERFACING NEAR REAL TIME AEROSOLS WITH CLOUD MICROPHYSICS	PiSe, DaMa, KlIv, HaDh, RaBR,	t-code		
PH6.5	VALIDATION AND TESTING	MoMo, AbAm, LaRo, EmGl, PiSe, DaMa,	report		
PH6.6	Ensure consistency across CSCs between treatment of aerosols, clouds and radiation (related to PH6.2)	LaRo,	Documentation		
PH6.7	Develop, maintain and evaluate the dust modeling function. MF plans to evaluate an AROME-DUST configuration in pre-operational mode. Algeria makes a regular evaluation of an operational version.	MoMo, ViGu, JoGu,	Documentation		

ACCORD WorkPackage description : PH7

WP number	Name of WP
PH7	Interface issues between the surface and the atmosphere
WP main editor	**Patrick Samuelsson, Bogdan Bochenek, Eric Bazile, Wim de Rooij**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
RaHa,	Rafiq Hamdi,	RMI Belgium	2
RMINe2,	RMI-Newcomer2,	RMI Belgium/D	9
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
NaTh,	Natalie Theeuwes,	KNMI Netherlands	1
NaTh, ,	Natalie Theeuwes, Newcomer-KNMI-2,	KNMI Netherlands/D	5
BoBo, GaSt,	Bogdan Bochenek, Gabriel Stachura,	IMGW Poland	6
		ARSO Slovenia	3
PaSa,	Patrick Samuelsson,	SMHI Sweden	1

WP objectives and priorities

This WP deals with interaction issues between the surface and the atmosphere and focuses especially on a few topics including stable boundary layers, ALARO-SURFEX coupling, the role of the lowest model level and surface properties, currently TEB, included in the atmospheric parameterizations.

The stable boundary layer and our inability to properly model it, with consequences for near-surface essential variables like e.g. T2m, has been a long standing problem. This subject was brought up in a side meeting of the 2022 All Staff Workshop and a summary of the discussion and suggested ways forward is given via this link. In this WP we will first look into the items additional term to scalar-flux formulations and learn from relevant observations via our academic contacts.

The coupling of ALARO to SURFEX includes a number of issues, some are directly SURFEX related and will be covered by tasks in SU3 and SU6 while some are dedicated to the interface between ALARO and SURFEX codes and will be covered by tasks in this WP.

With an increasing number of atmospheric vertical levels we tend to push the lowest model level closer to the surface. For stable boundary layers (BLs) this is often beneficial since they are characterised by thin BLs, however, for neutral and unstable BLs the enforced homogeneous atmospheric conditions close to the surface have no support in reality. Tasks in this WP will be dedicated to investigate the consequences for atmospheric-surface interactions of very low lowest model levels and investigate alternative approaches.

Research and development are published where very tall buildings (O100m) present in the TEB tile are explicitly handled in the atmospheric code of the Meso-NH model, including parameterizations of fluxes between model levels and the buildings. This research and development is now being transferred to the AROME-SURFEX context which will change the until now strict interface between SURFEX and AROME/ALARO at the lowest model level.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	Code contrib to repository (About code deliverables (if any))	Expected delivery (MM/YY)
PH7.1	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.	BoBo, GaSt, MaLa, NePr,			
PH7.2	Implement multi-layer coupling between SURFEX-TEB and AROME for modelling of the urban influence of high-rise cities as described by Schoetter et al. for Meso-NH.	RMINe2, NaTh,		IAL	
PH7.3	Study the influence of snow, ice, vegetation and the impact of the multiple energy balance scheme on the model boundary layer under stable conditions. 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. (see also SU3.10)				
PH7.4	Follow up task from the stable-boundary layer side meeting at ASW in Ljubljana 2022: - Discuss which relevant observational data sets Danijel Belusic and Larry Mahrt know, which ones they can make available. Get details on the characteristics of these data sets, like any useful info how they can be used for diagnosing space-time variability in SBL. - Test any ideas from academic studies of SBL, like from further investigations by the COSMO team and Dmtrii Mironov, on how to improve parametrizations.				
PH7.5	Investigate an hypothesis: Currently the only information provided to the atmosphere from the surface is the grid-average of fluxes (momentum, sensible, latent). The hypothesis is that also the information of sub-grid variability of these fluxes (e.g. sub-grid standard deviation of fluxes) could be used to improve e.g. the triggering of convection in the atmosphere.				
PH7.6	Risk assessment of lowest model level: We see activities where the lowest model level is pushed closer and closer to the ground. In general it is agreed that this is beneficial for the stable boundary layer but nothing says that this is true for the neutral or unstable boundary layer. On the contrary it may be harmful for the results. However, we currently lack any understanding for this. The purpose is to investigate and quantify the impact of lowering the lowest model level on surface-atmosphere energy exchange.	PaSa,			

ACCORD WorkPackage description : PH8

WP number	Name of WP
PH8	**On the interface of Physics with Dynamics (and time stepping)**
WP main editor	**Ludovic Auger, Emily Gleeson, Petra Smolikova, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
MaHr,	Mario Hrastinski,	DHMZ Croatia/D	1
PeSm,	Petra Smolíková,	CHMI Czech	1

WP objectives and priorities

This WP lists specific tasks that are at the interface between physics and dynamics, in terms of codes and of scientific interest.

1) 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.

2) Attention is given to the relative roles of horizontal and vertical diffusion (turbulence) across 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. This re-assessment of SLHD and gridpoint-based dissipation also is in link with hyper-resolution model design.

3) For the sake of numerical cost, and with a view on hyper-resolution model design, it could be of interest to study time split solutions in which the dynamics tendencies would be computed over a shorter time step than the physics (rather than compute all tendencies with a same, short time step). Time splitting per se will require specific work in some future, regarding its relevance on numerical stability and accuracy of solution. The task described in this WP is about studying the needed code design for enabling a time split facility in the common codes.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
PH8.1	Evaluate the impact of changing the thermodynamics variable for specific parametrisations or diagnostic computations. 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 computation 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.				
PH8.2	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.				
PH8.3	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.				
PH8.4	Using the 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. Design a method to determine the resolved TKE. Design of a scale aware mixing length. Testing of an experimental setup enabling to test schemes in multiscale environment (the cascade of resolutions 4km, 2km, 1km, 500m on roughly the same territory). Redesign of the diffusion coefficient used in SLHD and being a monotonic function of the total flow deformation along the terrain-following vertical levels.	MaHr,			

PH8.5	Study the code design in order to enable a time split approach within the ACCORD models. The idea would be to allow to compute physics tendencies over time steps significantly larger than the update of dynamics terms. One main purpose eventually would be to save computational cost for hyper-resolution models. The task described here is focussing on proposing a code design, taking advantage of the current re-factoring efforts of our common codes within code adaptation (eg **SPTR**).				
PH8.6	Further design and code adaptation of DDH. The needs for further developments of the DDH tool as such could come from scientific needs (physics-dynamics interface, new tendency terms), in link with SPTR (code adaptation to GPU etc.), fixing bugs in the new flexible DDH code. It is important to use the same name accross the CSCs and ARPEGE for the same physical flux(es) (when relevant) in order to easily use them in the "ddhtoolbox". *As a comment: please note that work consisting in using the DDH tool for scientific studies or evaluation of model versions should be described and reported in the relevant scientific WPs (mostly physics, sometimes dynamics or perhaps also MQA).*				

ACCORD WorkPackage description : PH10

WP number	Name of WP
PH10	Fully stochastic physics parametrizations
WP main editor	**Martina Tudor, Jeanette Onvlee, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
MeSh,	Metodija Shapkalijevski,	SMHI Sweden	2

WP objectives and priorities

The aim of this WP in general is to explore the literature and to extend our R&D activities in the domain of stochastic parametrizations, and to widen the range of knowledge to any of the relevant physics components for km/hm-scale models (thus not only deep convection). Currently we have a few approaches for upper-air stochastic parameterizations in the ACCORD community:
- the cellular automata (CA) described in 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 one 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 work undertaken at MF lies on the edge between the physics and EPS thematics, and focusses on physics-aware perturbation strategies. In Bouttier etal (2021 https://link.springer.com/article/10.1007/s10546-021-00682-6) the impact of three different perturbation strategies (SPPT, iSPPT, RP) applied on eleven different model parameters, is studied with respect to 1D model behaviour and LES simulations. One of the outcomes of this study, namely the appearance of model biases due to the parameter perturbations, is currently under investigation for the RP method (recent results have been presented at the ACCORD EPS workshop, April 2022).
Fleury etal (2022 https://rmets.onlinelibrary.wiley.com/doi/epdf/10.1002/qj.4242) describe the implementation in AROME of the physics-aware stochastic perturbation method for the turbulence scheme, introduced by Kober and Craig (2016 Journal of the Atmospheric Sciences, 73(7), pp. 2893–2911).
Most of these studies have been conducted in the 1D model framework, the plans are to evaluate them in the 3D model context. It is also recalled that A. Fleury is to complete her PhD by 2023-2024.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
PH10.1	Develop a stochastic formulation for intermittent turbulence in the stable BL turbulence parametrization, along the lines suggested by Vercauteren (2022) (see also PH1.5). Assess this formulation, also with MUSC.	MaKa, 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		reports		
PH10.3	study several approaches for implementing some flavour of stochasticity within the physics parametrizations. Note: ref paper are cited in the description header. This task references the PhD work by Axelle in the CNRM/GMME group.		results on the alleviation of model biases from perturbation strategies (eg RP); 3D case studies		

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
StSc,	Stefan Schneider,	ZAMG Austria/D	3
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech/D	2
EkKo,	Ekaterina Kourzeneva,	FMI Finland	3
CaBi, NaFo, SoMa,	Camille Birman, Nadia Fourrié, Sophie Marimbordes,	Météo-France	17.5
MaMo,	Maria Monteiro,	IPMA Portugal/D	1
ViTa,	Viktor Tarjani,	SHMU Slovakia	2
MaLa,	Matjaž Ličar,	ARSO Slovenia	3
PaSa,	Patrick Samuelsson,	SMHI Sweden	1.5

WP objectives and priorities

The main objective is to implement advanced data assimilation algorithms for the surface assimilation framework.

New and old algorithms are based on different versions of Optimum Interpolation (OI) for horizontal analysis and Kalman Filter or OI for analysis in vertical. For Kalman filter, the Simplyfied Extended Kalman Filter (SEKF), Short Time Augmented Extended Kalman Filter (STAEKF), Ensemble Kalman Filter (EnKF) are developed. For satellite observations, both retrievals and radiances will be considered. Work on observation operators, needed to assimilate satellite radiances, is presented here and in SU2. Currently in the code, mathematical and physical parts are not separated. This separation is planned, to make further developments easier.

For horizontal analysis, two software packages are developed and used, CANARI (all CSCs) and pysurfex/TITAN/gridPP (HARMONIE-AROME CSC). The plan is that CSCs will continue these developments.

Ways towards a coupled atmosphere-surface data assimilation system will be searched together with the UA Data Assimilation team.

CSC details:
HARMONIE-AROME: Short term plans (2023): Continue development of SEKF and pysurfex/TITAN/gridPP in combination with multi-layer ISBA physics and, in parallell, explore and develop EnKF algorithms. Continue study possibilities of using crowdsource data (e.g. Netatmo) with the pysurfex/TITAN/gridPP framework. Medium to long term plans (2024-2025): Includes investigation of evolving B. Includes analysis for 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.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
SU1.1	Develop/assess OI/SEKF/EnKF for soil, snow and vegetation using SYNOP data in combination with Diffusion Soil, Explicit Snow and MEB schemes in SURFEX/SODA.	StSc, AsBa, MaHo, TrAs, JoBl, MaMo, ViTa, MaLa, PaSa,	see subtasks		
SU1.1.1	Consider, develop and evaluate OI/SEKF/EnKF for diffusion soil scheme as implemented in SURFEX/SODA.	MaLa,	t-code		
SU1.1.2	Consider, develop and evaluate OI/SEKF/EnKF for explicit snow scheme as implemented in SURFEX/SODA.	MaLa,	t-code		
SU1.1.3	Combine the development in SU1.1.1-1.1.2 and set up a test-operational system based on OI/SEKF/EnKF for soil, snow and vegetation.	MaLa, PaSa,	report		
SU1.1.4	Validation of SEKF surface assimilation with SYNOP observations and operational upgrades.	ViTa,	report		
SU1.2	For CANARI and SODA in HARMONIE-AROME, (i) consider fractional covers instead of the land-sea mask (ii) improve using of patches (iii) use simulated snow density. For AROME & ARPEGE, item (iii) "exclude need of climatological snow density" will be further explored.	EkKo, AsBa,	t-code, configuration		
SU1.3	Further develop snow analysis and assimilation of snow extent in HARMONIE-AROME. Developments on snow analysis in CANARI for AROME-France and ARPEGE.	CaBi, NaFo, AsBa, MaHo,	t-code report		
SU1.4	Develop/assess EKF for sea ice, using satellite products in combination with the SICE scheme. Includes bias-aware EKF.		t-code, code		
SU1.5	Investigating the use of Land-SAF product when building the Jacobian		t-code,		
SU1.6	Surface analysis strategy for AROME-MAROC		configuration		
SU1.7	Continue the development of pySurfex including TITAN and gridPP and coupling to SODA.	AsBa, TrAs,	t-code, code, report		
SU1.8	Steps forward to develop EnKF for surface in HARMONIE-AROME. Assimilation of raw radiances from SSMIS, AMSR2 and MWRI and of Sentinel 1 SAR observations to update soil moisture, SWE, surface temperature and vegetation optical depth. For that, explore forward models CMEM/HUT. Develop methodology for a consistent upper air and surface perturbations in EnKF. Develop methodology for a multi-patch approach.	JoBl,	t-code, code, report		

SU1.9	Strategic and practical steps 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.	CaBi, SoMa, AsBa, TrAs, JoBl,	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.	StSc, AsBa, TrAs,			
SU1.11	Tuning of CANARI/MESCAN and OI soil assimilation	MaMo, MaLa,			

ACCORD WorkPackage description : SU2

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
SaOs, PoSc, PoSc, StSc, StSc,	Sandro Oswald, Polly Schmederer, Polly Schmederer, Stefan Schneider, Stefan Schneider,	ZAMG Austria	6.5
EkKo, BiCh,	Ekaterina Kourzeneva, Bin Cheng,	FMI Finland	2
CaBi, NaFo, ZiSa,	Camille Birman, Nadia Fourrié, Zied Sassi,	Météo-France	8.25
HeKo, BaSz, BaSz, HeKo,	Helga Kollathne Toth, Balazs Szintai, Balazs Szintai, Helga Kollathne Toth,	OMSZ Hungary	11
YS1,	NewcomerIPMA1,	IPMA Portugal	3
MiNe,	Michal Nestiak,	SHMU Slovakia	0.5
MaLa,	Matjaž Ličar,	ARSO Slovenia	2
PaSa,	Patrick Samuelsson,	SMHI Sweden	1

WP objectives and priorities

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. Attempts are planned to assimilate both retrieval products (such as soil moisture and LAI) and radiances, using appropriate observation operators. For assimilation, priority should be given to operationally available satellite products (temporary research products should in principle be avoided). Other types of unconventional surface observations may be used for verification, e.g. sea-ice mass balance (SIMBA) buoys.
This WP includes data pre-processing, as a preparation for making them available for assimilation in SU1. This includes the aspect of transferring satellite observations from the satellite grid to the model grid (footprint size, superobbing and supermodding) and technical aspects of entering data into ODB.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
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].	PoSc, StSc, HeKo, MaLa, PaSa,			
SU2.2.1	[ASCAT, AMSR-2, ...] - [EnKF] - [8.1]		report, code		
SU2.2.2	[ASCAT, SMOS] - [SEKF] - [8.0]	HeKo,			
SU2.3	Test satellite sea-ice extent products with finer resolution (in-house Met.no product and AMSR-2 based product) in HARMONIE-AROME.	YuBa,	report, code		
SU2.4	Explore the possibility to use SIMBA buoys for verification of sea-ice conditions.	BiCh,	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].	SaOs, CaBi, NaFo, ZiSa,			
SU2.5.1	[LSA-SAF radiation] - [tbd] - [tbd]		report		
SU2.5.4	[satellite derived skin temperature] - [2D OI in CANARI] - [AROME]	CaBi, NaFo, ZiSa,	publication		
SU2.6	Examine the use of amateur weather observations (like Netatmo) in surface assimlation, using gridpp	TrAs, MiNe,	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].	EkKo, BaSz, HeKo, MaHo,			
SU2.7.1	[H-SAF and Cryo] - [sEKF] - [8.1]				
SU2.7.2	[H-SAF] - [sEKF] - [8.0]	BaSz, HeKo,			
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].	PoSc, StSc, BaSz, YS1,			
SU2.8.1	[Sentinal-3-based LAI] - [sEKF] - [8.1] daily updated LAI for AROME	PoSc, StSc, BaSz,	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]		report		

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
KnEi,	Kerroumi Nour El Isslam,	ONM Algeria	3
RaHa, ThVe, StCa,	Rafiq Hamdi, Thomas Vergauwen, Steven Caluwaerts,	RMI Belgium	12.25
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech	4.5
SoNi ,	Søren Borg Nielsen ,	DMI Denmark/D	2
EkKo, OlSa,	Ekaterina Kourzeneva, Olli Saranko,	FMI Finland	3
AdNa, YaSe,	Adrien Napoly, Yann Seity,	Météo-France	5.5
NeSU1, NeSu2, VaMa, PLM,	NewcommerSU1, NewcommerSU2, Valéry Masson, Patrick Le Moigne,	Météo-France/D	24
EmGl,	Emily Gleeson,	MET Eireann	1
NaTh,	Natalie Theeuwes,	KNMI Netherlands	1
MiNe,	Michal Nestiak,	SHMU Slovakia	0.5
SaVi,	Samuel Viana,	AEMET Spain	4
MeSh, KIIv, PaSa,	Metodija Shapkalijevski, Karl-Ivar Ivarsson, Patrick Samuelsson,	SMHI Sweden	4.25

WP objectives and priorities

The main objective is to progress with better physics by exploring advanced SURFEX components, also not used before in ACCORD CSCs.

With respect to the nature tile, advanced physical components include the Diffusion Soil scheme (ISBA DIF), Explicit Snow scheme (ES) and Multi-Energy Balance (MEB) scheme. 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, options allowing prognostic LAI (A-gs) could provide better surface resistance and transpiration control and opens up the way for assimilation of LAI products (SU2).

Over the land, errors in forecasting low temperatures are related to wrong representation of the stable boundary and surface layer in NWP. Studies are planned, to better understand the problem and to move forward in its solution.

Over the sea tile, turbulent fluxes are calculated using different versions of ECUME scheme. Correct representation of surface fluxes over the sea in important for the simulation of large scale processes. Also, it is linked to the succesful forecasts of fog over the sea. The objective is to test the performance of difference formulations of the ECUME against available observations and to study its relation to the forecasting of fog.

Urban tile, which is described by TEB model, covers relatively small fractions, but is important for the local weather. It is especially important when the model resolution increases. TEB is implemented without data assimilation. Performance of TEB for different city types and different weather conditions needs validation against dedicated obesrvations, including measurement campaigns.

Inland water tile is represented by FLake. FLake is currently operational in the HARMONIE-AROME for MetCoOp. It is implemented without data assimilation, thereby monitoring of its performance is important.

Observations needed for the validation are partly provided by QA3, with tools like Monitor and HARP. However, they should be complimented by special observations: from measurement campigns, non-conventional near-surface observations, flux tower data, and satellite products. All parameterizations include parameters with some level of uncertainty. There are parameters in SURFEX which are a matter of tuning. Tuning may give a better performance of a certain ACCORD cycle release for a certain domain.

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 ISBA-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.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
SU3.1	Test and validate the behaviour of individual components, as well as the full combination, of DIF, ES, (MEB) in the ACCORD NWP system. Utilize a combination of offline SURFEX, MUSC, and the full 3D model depending on the type of study and coordinate with HCLIM efforts.	EkKo, AdNa, YaSe, EmGl, MaHo, SaVi, MeSh, PaSa,	see subtasks		
SU3.1.1	Over different domains, examine biases in the ACCORD NWP system when the full combination of DIF, ES, (MEB) are activated in combination with recommended namelist settings.	EmGl, PaSa,	report		
SU3.1.2	By namelist modifications, parameter tuning and/or code modifications try to reduce any biases identified in SU3.1.1	EmGl,	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.		t-code, code, configuration		
SU3.3	Evaluate the performance of TEB on kilometric and sub-kilometric resolution in NWP and climate AROME/ALARO. For validation, use dedicated observations, also from measurement campaigns. Link to HR1.5. Examine the potential use of, until now, non-utilized options in TEB.	KnEi, RaHa, ThVe, OlSa, AdNa, YaSe, NeSu2, VaMa, PLM, NaTh,	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.	AdNa, YaSe,	report		
SU3.6	Evaluate and validate ECOCLIMAP-SG in cy48t1	AdNa, YaSe, NeSU1,			
SU3.7	Study the performance of the ECUME scheme formulations in HARMONIE-AROME. Study the errors in fog prediction over the sea, e. g. links between the cloudiness parameterization (optical depth) and surface fluxes. Link with PH7.	EmGl, SaVi, KIIv,	report, configuation		
SU3.8	Evaluation of ALARO-1 screen level interpolation in SURFEX (N2M=3 option in cy43h)		report, t-code (?)		
SU3.9	Validation of ALARO-1 with SURFEX (ISBA), implementation of effective roughness.	KnEi, MiNe,	report, t-code		
SU3.10	Better understand the stable regime in surface and boundary layer and improve model performance in stable conditions. Includes testing of XRIMAX, stability functions, roughness, diagnostics, use of the RSL scheme, vertical (lowest model level) and horizontal resolution. Includes use of dedicated observations, also from measurement campaigns. See also PH7 and SU4.8.	EkKo, MaHo, SaVi, MeSh,			
SU3.12	Evaluate prognostic LAI (A-gs) for HARMONIE-AROME, AROME and ALARO				
SU3.13	Coupling to hydrological processes (OASIS-TRIP)				

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
EkKo,	Ekaterina Kourzeneva,	FMI Finland	1
BoPa,	Bolli Pálmason,	IMO Iceland	0.5
SaVi,	Samuel Viana,	AEMET Spain	1.5
MeSh, PaSa,	Metodija Shapkalijevski, Patrick Samuelsson,	SMHI Sweden	2

WP objectives and priorities

Main objective of this WP is development of new SURFEX model components or further development of them.

In SURFEX, development of existing, under-developed, or still missing components continue, describing more processes and implementing more methods of diagnostic. During this RWP period, the planned development by NWP team includes: increase in sophistication for the Simple Ice scheme (SICE), improving the model performance over snow/glacier areas, 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 (rough sublayer scheme RSL), exploring the use of 1-D ocean model GOTM. 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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
SU4.1	Improve representation of glaciers by use of albedo observations.	EkKo, BoPa, YuBa,	t-code		
SU4.2	Further development of SICE scheme (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,	t-code		
SU4.7	Evaluation of the phenology in ISBA-Ags.		report		
SU4.8	Continue development of the roughness sublayer scheme (RSL): Evaluate of the scheme over different domains and stability ranges, in connection with SU3.10 and PH7.3. Describe implementation & performance in scientific manuscript.	SaVi, MeSh,			
SU4.9	In SURFEXv8.1 of SODA the EKF algorithms are tightly connected to the ISBA tile. However, algorithms and tiles should be separated from each other. Work on this is ongoing initiated by sea-ice-EKF development.	YuBa,			
SU4.10	New surface layer turbulence a la Niels Woetmann Nielsen.	KPNi			
SU4.12	Implementation of 1D sea model GOTM into SURFEX	EkKo, YuBa,	t-code		
Whish-list:					
SU4.1	Develop a physically based glacier model for SURFEX based on the Explicit Snow Scheme.	BoPa	t-code		

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
KnEi,	Kerroumi Nour El Isslam,	ONM Algeria	2
SaOs,	Sandro Oswald,	ZAMG Austria	0.5
SaOs,	Sandro Oswald,	ZAMG Austria/D	1
RaHa,	Rafiq Hamdi,	RMI Belgium	2
AnSl, AnSt,	Ana Šljivić, Antonio Stanešić,	DHMZ Croatia/D	2
EkKo,	Ekaterina Kourzeneva,	FMI Finland	2
OlSa,	Olli Saranko,	FMI Finland/D	4
BoPa,	Bolli Pálmason,	IMO Iceland	2
BoPa,	Bolli Pálmason,	IMO Iceland/D	4
EmGl, GeBe, GeBe, GeBe,	Emily Gleeson, Geoffrey Bessardon, Geoffrey Bessardon, Geoffrey Bessardon,	MET Eireann	4.5
GeBe, ThRi,	Geoffrey Bessardon, Thomas Rieutord,	MET Eireann/D	10.5
PaSa,	Patrick Samuelsson,	SMHI Sweden	1

WP objectives and priorities

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. We will study the feasibility of creating the fine (hectometric scale) land cover map over Europe using Machine Learning techniques. 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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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.	KnEi, RaHa,	database, reports, documentation, code		
SU5.2	Soil maps activities. Soilgrids corrections and studying impact. Corrections will be done mainly for Iceland, Greenland, Svalbard. Orography GMTED2010 in MF models. Impact studies are also described in MQA3.	SaOs, BoPa,	database, reports, documentation, code		
SU5.3	Tree height data activities. Suggest and apply suitable combinations of tree height data.		report, code		
SU5.4	Lake database (GLDB) Participate in GLDB developments and studying the impact.	EkKo,	database, code, reports		
SU5.5	ECOCLIMAP SG activities. Examining and participate in developments. Impact studies are also described in MQA3.	BoPa, MaHo, SaVi, PaSa,	report		
SU5.6	Development of the fine (hectometric) scale Cover map for Europe using ML approach. Link with DEDODE. Tools (with documentation) for handling of physiography data. Work to increase the efficiency of PGD: optimization and clipping. Link with DEODE.	SaOs, AnSl, AnSt, EkKo, OlSa, BoPa, EmGl, GeBe, ThRi, TrAs,			

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
OlNu, ErWa, GhFa, CLB, CLB, FlNi,	Olivier Nuissier, Eric Wattrelot, Ghislain Faure, Cindy Lebeaupin-Brossier, Cindy Lebeaupin-Brossier, Fleur Nicolay,	Météo-France	20.5
HdV,	Hans de Vries,	KNMI Netherlands	2
PaSa,	Patrick Samuelsson,	SMHI Sweden	0.5

WP objectives and priorities

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 (see also SU4). Ireland is working on coupling Harmonie-AROME with WW3 and 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.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
SU6.1	Set-up of coupled system AROME-WW3-NEMO	ErWa, GhFa, CLB, FlNi,			
SU6.1.1	Validation of the set-up AROME-NEMO within cy43	ErWa, GhFa, CLB,	t-code		
SU6.1.2	Development and validation AROME-WW3-NEMO	CLB, FlNi,	t-code		
SU6.1.3	Validation of Arome-NEMO (see also E11.5)				
SU6.2	Set-up of coupled system ALARO-WAM-NEMO				
SU6.2.1	Development and validation of an ALARO-WAM setup				
SU6.2.2	Development of ALARO-WAM-NEMO				
SU6.3	Continued development and evaluation of coupled HARMONIE-AROME-OASIS- setups in different configurations	OlNu, ErWa, HdV, MaMu, YuBa, PaSa,			
SU6.3.1	Wave model -WW3. With operational NWP application in mind.		t-code		
SU6.3.2	Also with ocean model and sea-ice model -WW3-GOTM-SICE in Norway	MaMu,	t-code		
SU6.3.3	Further improve AROME/CMO coupling for tropical cyclone prediction	OlNu, ErWa,			

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
IsBo,	Islam Bousri,	ONM Algeria	2
AlKa, IsSc, MaDa,	Alexander Kann, Irene Schicker, Markus Dabernig,	ZAMG Austria	4
IrOd, IvVu,	Iris Odak Plenković, Ivan Vujec,	DHMZ Croatia	1.5
IrOd, IvVu,	Iris Odak Plenković, Ivan Vujec,	DHMZ Croatia/D	2
ClBr, LaRa, GaMo, OlMe, LePf, MaTa, MiZa,	Clement Brochet, Laure Raynaud, Gabriel Moldovan, Olivier Mestre, Leo Pfitzner, Maxime Taillardat, Mikhael Zamo,	Météo-France	23
KJR,	Katalin Javorne Radnoczi,	OMSZ Hungary	3
BaAl,	Badreddine Alaoui,	Maroc Meteo	4
JoBr,	John Bjornar Bremnes,	MET Norway	2
MeSe, FaBü, EmSa,	Meral Sezer, Fatih Büyükkasabbaşı, Emine Say,	MGM Turkey	5

WP objectives and priorities

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. 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.

Work using analog methods will be further developed, while attention will also 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.

Spatial resolution and ensemble size remain insufficient to accurately predict high-impact weather events. In order to improve spatial resolution of precipitation convolutional neural networks are tested as a tool to downscale to a horizontal resolution of ~500m, while the ensemble size can be increased to O(1000) members using generative adversarial networks.

Across the different calibration methods is a focus on prediction of high-impact and extreme events, introducing additional calibrated parameters and gridded calibration products.

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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, including reliable, calibrated forecasts of extreme events. 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.	MaDa, JoBr, MeSe, FaBü, EmSa,	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.	IsSc, OlMe, LePf, MaTa, MiZa, KJR,			
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	IsBo, AlKa, ClBr, LaRa, GaMo, OlMe, LePf, MaTa, MiZa,	Trained neural networks, scientific publications		
E6.5	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.	IsBo, IrOd, IvVu, BaAl, MeSe, FaBü,	non-t-code		

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, HoTa,	Geert Smet, Joris Van den Bergh, Hossein Tabari,	RMI Belgium	3.5
EnKe,	Endi Keresturi,	DHMZ Croatia	0.75
HeFe,	Henrik Feddersen,	DMI Denmark	1.25
AAA, LaRa, ArMo, YEO, BaTa, FlRo, MaPl, MaPl, FrBt, GaCo, HuMa, AdWa,	Alexandre Albert-Aguilar, Laure Raynaud, Arnaud Mounier, Youness El Ouartassy, Bachar Tarraf, Flore Roubelat, Matthieu Plu, Matthieu Plu, François Bouttier, Gabriel Colas, Hugo Marchal, Adrien Warnan,	Météo-France	70.75
MaKo, NaSz,	Marcin Kolonko, Natalia Szopa,	IMGW Poland	2
SiTa,	Simona Tascu,	Meteo Romania	2
MBell,	Martin Bellus,	SHMU Slovakia	1
AlCa, MaCo, JuGo, JoMo,	Alfons Callado , Maria Cortes, Juan Gomez Navarro, Joan Montolio,	AEMET Spain	9
AkJo,	Åke Johansson,	SMHI Sweden	3

WP objectives and priorities

Ideally, 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. It is a priority that the developments will (i) facilitate the *decision-making of duty forecasters and 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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
E7.1	Objective identification of convection objects and of severe storms in ensemble outputs, using deep NN, evaluation against radar observations. Development of a deep-learning based clustering of ensemble members to identify a small number of informative scenarii, application to heavy rainfall events.	EnKe, LaRa, ArMo, MaPl, MaKo, NaSz, SiTa, MBell, AkJo,	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 AROME-EPS & design of model climate dataset (Contr. MF)	HeFe, AAA, LaRa, AlCa, JoMo,	EFI in operations at Météo-France. Early warning products for UWC-West forecasters		
E7.3	Development of decision making criteria for renewable energy: power cut outs, wind/solar energy production probabilistic forecast. Clustering methods to extract user-relevant scenarii from ensembles (Contr. MF).	GeSm, JvdB, LaRa, ArMo, FlRo,	report, scientific publications		
E7.4	Development of decision making criteria for agriculture : coupling EPS with irrigation models. Calibration of weather inputs and/or irrigation model outputs will be investigated.	LaRa, BaTa,	report, scientific publications		
E7.5	Development of decision making criteria for hydrological and coastal flooding applications	FrBt, AdWa,	report, scientific publications		
E7.6	Development of decision making criteria for transportation safety (road, aviation, etc.). Force a road weather model with an ensemble of convection-permitting models. 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, HoTa, GaCo,	scientific publication(s) /report(s)		
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, YEO, MaPl,	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)	HuMa, AlCa, MaCo, JuGo,			
E7.10	Development of probabilistic forecast products specifically designed for aviation. In close cooperation with operational aviation forecasters a set of meteorological events which are critical to aviation safety will be selected and for which probabilities will be calculated and presented in ways that are informative and useful. In addition, forecast products that display the forecast uncertainty will be developed.	AkJo,	scientific publication(s) /report(s)		
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	EnKe, SiTa, MBell,	non-t-code		

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
ChWi, FlWe, ClWa,	Christoph Wittmann, Florian Weidle, Clemens Wastl,	ZAMG Austria	8
HeFe,	Henrik Feddersen ,	DMI Denmark	1.25
OlNu, GrRo, LaRa,	Olivier Nuissier, Gregory Roux, Laure Raynaud,	Météo-France	12
GaTo, KJR,	Gabriella Toth, Katalin Javorne Radnoczi,	OMSZ Hungary	9
BaAl, MoJi,	Badreddine Alaoui, Mohamed Jidane,	Maroc Meteo	5
InFr, OlVi,	Inger-Lise Frogner, Ole Vignes,	MET Norway	0.5
SiTa,	Simona Tascu,	Meteo Romania	2
MaDe, MBell,	Maria Derkova, Martin Bellus,	SHMU Slovakia	4.5
UlAn,	Ulf Andrae,	SMHI Sweden	0.5
AlGü, MuBa,	Alper Güser, Mustafa Başaran,	MGM Turkey	4

WP objectives and priorities

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.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
E8.1	Maintenance and evolution of the AROME-EPS-France system: follow adaptations for e-suites, porting to next MF HPC & mirror suite	GrRo, LaRa, MBell,			
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, BaAl, MoJi,	Arome-EPS for Oversea domains in operations at Météo-France		
E8.3	Optimization, tuning and maintenance of operational AROME based EPS system C-LAEF at ECMWF HPC. First test suites with C-LAEF at 1km. New HPC at ZAMG - migration.	ChWi, FlWe, ClWa,	non-t-code		
E8.4	Introduction of ensemble data assimilation into convection-permitting ensemble system at OMSZ. Continuous tuning, optimization and operationalization	GaTo, KJR,	non-t-code		
E8.5	Adaptation of C-LAEF to Turkish Domain	AlGü, MuBa,	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	MaDe, MBell,	non-t-code		
E8.7	Maintenance and evolution of the HarmonEPS system. Introduce system changes to support required HarmonEPS development.	InFr, OlVi, UlAn,			
E8.8	Maintenance and regular upgrades of the operational A-LAEF system running at ECMWF HPCF	SiTa,	non-t-code		
E8.9	Testing numerical stability and meteorological performance of perturbed forecasts run in single precision.	HeFe, GrRo, LaRa,	non-t-code		
E8.10	Development of an ALARO-based convection-permitting EPS coupled to the regional ensemble A-LAEF, running at SHMU HPC	MBell,	non-t-code		

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
ClWa,	Clemens Wastl,	ZAMG Austria	2
GeSm, MiVa,	Geert Smet, Michiel Vanginderachter,	RMI Belgium	1.5
EnKe,	Endi Keresturi,	DHMZ Croatia	1.25
HeFe,	Henrik Feddersen,	DMI Denmark	0.25
JaKa, KaHa, PiOl,	Janne Kauhanen, Karoliina Hämäläinen, Pirkka Ollinaho,	FMI Finland	9
LeDz, GrRo, LaDe, LaRa, OlNu, FrBt, AxFl,	Lena Dziura, Gregory Roux, Laurent Descamps, Laure Raynaud, Olivier Nuissier, François Bouttier, Axelle Fleury,	Météo-France	27.5
GaTo,	Gabriella Toth,	OMSZ Hungary	1
AlHa, JaFa, JaFa,	Alan Hally, James Fannon, James Fannon,	MET Eireann	3.25
WdR, SvdV, JaBa, CaSe,	Wim de Rooij, Sibbo van der Veen, Jan Barkmeijer, Camiel Severijns,	KNMI Netherlands	7
InFr, OlVi,	Inger-Lise Frogner, Ole Vignes,	MET Norway	3
MBell,	Martin Bellus,	SHMU Slovakia	1
UlAn,	Ulf Andrae,	SMHI Sweden	1

WP objectives and priorities

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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). Lena Dziura is investigating SPP and other perturbation schemes for AROME-EPS overseas.	LeDz, GrRo, LaDe, LaRa, OlNu, FrBt, AxFl,	Scientific publications, reports		
E9.2	Model perturbations for AROME-EPS at OMSZ. Work on SPPT, SPP.	GaTo,	Report		
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,	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.	JaKa, KaHa, PiOl, AlHa, JaFa, WdR, SvdV, JaBa, CaSe, InFr, OlVi, UlAn,	Namelist tunings. New code for new parameters and correlations.	IAL	12/24
E9.5	Improve stochastic parameter perturbations (SPP) with special focus on convective hazards (e.g. processes in microphysics).	ClWa, EnKe,	t-code	IAL	12/24
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	IAL	12/24
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.	MBell,	t-code		
E9.9	Test parameter sensitivity in 1D-model using the URANIE framework.	MiVa, HeFe, JaFa,	Report		12/23

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
GrRo, LaRa,	Gregory Roux, Laure Raynaud,	Météo-France	1.5
InFr, OlVi, NN,	Inger-Lise Frogner, Ole Vignes, NN,	MET Norway	10.5
MBell,	Martin Bellus,	SHMU Slovakia	1
PaEs,	Pau Escriba,	AEMET Spain	0.5

WP objectives and priorities

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, and the implemented perturbations of the initial conditions should lead to better spread and skill.

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
E10.1	Link with AROME EDA: use AROME EDA perturbations in AROME-France EPS initial conditions	GrRo, LaRa,			
E10.3	Explore the use of the EnVar, Hybrid EnVar and LETKF to create initial conditions for ensemble members. Test what perturbations are suitable and perform the best.	NN, PaEs,			
E10.5	Test different cycling strategies and retune initial perturbations.	InFr,	New tuning	other repo	12/24
E10.6	Preparation of flow-dependent B-matrix for local 3D-Var assimilation systems based on ALARO CMC using A-LAEF operational outputs	MBell,	non-t-code		
E10.7	Test the combination of EPS and 4D-Var, including EDA.	OlVi,	Feasibility to run 4D-Var in EPS mode with EDA		12/24

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
GeSm,	Geert Smet,	RMI Belgium	1
HeFe,	Henrik Feddersen ,	DMI Denmark	1
ArFo, MaMq,	Arnaud Forster, Maeva Marquillie,	Météo-France	17
JaFa,	James Fannon,	MET Eireann	0.75
AnSi, HaMc, RaGr,	Andrew Singleton, Harold McInnes, Rafael Grote,	MET Norway	10
UlAn, DaYa,	Ulf Andrae, Daniel Yazgi,	SMHI Sweden	2.5

WP objectives and priorities

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

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
E11.1	Perturbations to sea ice based on uncertainty estimates from the SIRANO sea-ice concentration product are being explored. Work on more sophisticated SST perturbations will continue based on feedback on the submitted publication (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 are considered. The same method could be used for some of the other surface parameters in PertSFC too (VEG, LAI, CV, Z0, ALB, TS, WG, SNOW) (also dependent on funding possibilities).	RaGr,			
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, HaMc, UlAn, DaYa,	First implementation	IAL	12/25
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	MaMq,	Scientific publications, reports		
E11.6	Impact of surface perturbations, in particular soil moisture perturbations, on prediction of high impact summer weather, such as thunderstorms and heat waves.	GeSm, HeFe, JaFa,	Scientific publications, reports		

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	1.25
CaLa, PiCe,	Carole Labadie, Pierrick Cebron,	Météo-France	16

WP objectives and priorities

Optimize use of lateral boundaries from global model

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
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,	Report or scientific publication		
E12.3	Improvements of the global ARPEGE-EPS, as the coupling system of AROME-EPS.	CaLa, PiCe,			

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
IsBo,	Islam Bousri,	ONM Algeria	1
FlWe,	Florian Weidle,	ZAMG Austria	0.5
AlDe,	Alex Deckmyn,	RMI Belgium	1
CaPe,	Carlos Perata ,	DMI Denmark	2
AhMe,	Ahto Mets,	ESTEA Estonia	1
CaFo,	Carl Fortelius,	FMI Finland	2
BaAl,	Badreddine Alaoui,	Maroc Meteo	1
FaSi,	Fabiola Silva,	KNMI Netherlands	2
AnSi ,	Andrew Singleton,	MET Norway	5
MaPe,	Martin Petras,	SHMU Slovakia	0.5
GeMo,	Gema Morales,	AEMET Spain	0.5
DaYa, AkJo,	Daniel Yazgi, Åke Johansson,	SMHI Sweden	1.5

WP objectives and priorities

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 2023 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.

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
MQA1.1	**Harp User Support** The harp slack channels will continue to be the principal way for harp-users to get peer-support Work will continue on an online harp book covering 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.	AhMe, CaFo, AnSi , GeMo,	documentation, peer support		
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.	IsBo, AlDe, AnSi , MaPe, DaYa	code updates	harp	continuous
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.	AlDe, CaPe, FaSi, AnSi , AkJo,	code updates	harp	
MQA1.4	**Harp standard verification set** Development of the harpUserScripts for easy generation and presentation of a standard set of deterministic and probabilistic scores will continue. Extraction of observations and forecasts into files readable by harp will be done in liaison with task SY2.13.	FlWe, AnSi ,	consolidation of harpuserScripts	harp	

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
PoSc, ChZi,	Polly Schmederer, Christoph Zingerle,	ZAMG Austria	2
ChWi, PhSc,	Christoph Wittmann, Phillip Scheffknecht,	ZAMG Austria/D	2.5
AlDe, GeSm, JvdB, RMINe3,	Alex Deckmyn, Geert Smet, Joris Van den Bergh, RMI-Newcomer3,	RMI Belgium	3
BoTs, MiTs, KoMl,	Boryana Tsenova, Milen Tsankov, Konstantin Mladenov,	NIMH Bulgaria	4
BoTs, MiTs, KoMl,	Boryana Tsenova, Milen Tsankov, Konstantin Mladenov,	NIMH Bulgaria/D	3
IrOd,	Iris Odak Plenković,	DHMZ Croatia	1
HeFe, KaHi,	Henrik Feddersen , Kasper Hintz,	DMI Denmark	1.5
CaFo,	Carl Fortelius,	FMI Finland	2
FlSu, ErWa, GhFa, JoSt, FaSt,	Florian Suzat, Eric Wattrelot, Ghislain Faure, Joel Stein, Fabien Stoop,	Météo-France	9
KJR, DaTa, BoTo,	Katalin Javorne Radnoczi, David Tajti, Boglarka Toth,	OMSZ Hungary	3
BaAl,	Badreddine Alaoui,	Maroc Meteo	1
GeGe, FaSi,	Gertie Geertsema, Fabiola Silva,	KNMI Netherlands	4
JJGA,	Juan Jesus Gonzalez Aleman,	AEMET Spain	3
DaYa, AkJo,	Daniel Yazgi, Åke Johansson,	SMHI Sweden	3.5

WP objectives and priorities

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.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
MQA2.1	Development of (a) new verification method(s), aiming to provide a deeper insight into the ability of the model/EPS system to represent the 3-D state of the atmosphere and (b) the processes determining cloud, convection and precipitation formation.	ChZi, CaFo, GeGe, JJGA, AkJo, DaYa	code		
MQA2.2	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), "Agreement scale" (Dey et. al, 2016) and "SLX" are candidates for such implementation.	PoSc, AlDe, HeFe,	Develop and test code, document results	harp	
MQA2.3	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 scores. 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.		Scripts/code and associated results of new developments	harp	
MQA2.4	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 (reviews of the paper which will be submitted in 2022). Extensions of this study will be done in 2023 with an implementation of the decomposition of the Brier score, which will allow us to define neighborhhod-based fiability diagram and ROC diagram. The last developments will be the basis of a new paper to be published in a peer-reviewed publication.	JoSt, FaSt,	Code, validation study in a peer-reviewed publication		
MQA2.5	Further development of tool to generate and present MSG SEVIRI simulated radiance data		Code, user documentation, validation study		
MQA2.6	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.	IrOd,	Reporting		
MQA2.7	Verify wind forecasts at levels relevant for wind farming	GeSm, JvdB, RMINe3, BoTs, MiTs, KoMl, IrOd, KJR, DaTa, BoTo,	Method and report		

MQA2.8	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 observations used in data assimilation, including non-conventional ones. E.g. all-sky radiances are known to be sensitive to cloud and precip. forecasts.This task is connected to the DA7.2.	KaHi, FlSu, ErWa, GhFa, FaSi,	Method and report		
MQA2.9	Develop verification methods/tools tailored for extreme event evaluations	ChWi, PhSc, BoTs, MiTs, KoMl, BaAl,	Method and report		
MQA2.10	Properly quantify skill versus spread in an EPS. Verify all members individually using U-statistics instead of the ensemble mean; verify against the perceived "truth" using the BLUE (Best Linear Unbiased Estimate) concept rather than against observations and/or analyses .	AkJo,	(i) Develop code and software that calculates the verification statistics for an operational system (ii) Make comparisons with the commonly used verification methods (iii) Describe the ideas and document the results from applying them in the form of an article in a peer reviewed journal.		2023

ACCORD WorkPackage description : MQA3

WP number	Name of WP
MQA3	Verification, evaluation and error attribution
WP main editor	**Carl Fortelius, Christoph Wittmann**

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

Participant Abbreviation	Participant	Institute	PersonMonth
SaChi, IsBo, WaCh, KnEi,	Sara Chikhi, Islam Bousri, Walid Chikhi, Kerroumi Nour El Isslam,	ONM Algeria	5
ChWi, FlWe, ClWa, NaAw, ChZi,	Christoph Wittmann, Florian Weidle, Clemens Wastl, Nauman Awan, Christoph Zingerle,	ZAMG Austria	5.5
PhSc,	Phillip Scheffknecht,	ZAMG Austria/D	1.5
GeSm, JvdB, RMINe3, MiVa,	Geert Smet, Joris Van den Bergh, RMI-Newcomer3, Michiel Vanginderachter,	RMI Belgium	6.5
AnSt, IrOd, EnKe, IvVu,	Antonio Stanešić, Iris Odak Plenković, Endi Keresturi, Ivan Vujec,	DHMZ Croatia	3
AnBu, AlTr, RaBr,	Antonín Bučánek, Alena Trojáková, Radmila Brožková,	CHMI Czech/D	7
AhMe,	Ahto Mets,	ESTEA Estonia	1
CaFo, EeSa,	Carl Fortelius, Eerik Saarikalle,	FMI Finland	6
InEt, CeLo, OlJa, AdNa, JMP, YaSe, OlNu, ErWa, GhFa, NiMe, JoSt, FaSt, YaPr, VeLi, HeBe, LeLa, BeVi,	Ingrid Etchevers, Cecile Loo, Olivier Jaron, Adrien Napoly, Jean-Marcel Piriou, Yann Seity, Olivier Nuissier, Eric Wattrelot, Ghislain Faure, Nicolas Merlet, Joel Stein, Fabien Stoop, Yann Prigent, Veronique Lion, Herve Benichou, Lea Launay, Benjamin Viard,	Météo-France	49.25
BoTo,	Boglarka Toth,	OMSZ Hungary	4
AlHa, CoCl, EmGl, EoHa, EoWh, JaFa, RóDa,	Alan Hally, Colm Clancy, Emily Gleeson, Eoghan Harney, Eoin Whelan, James Fannon, Rónán Darcy,	MET Eireann	7.75
KrKr,	Kristina Kryžanauskienė,	LHMS Lithuania	2
NaMa, KaKa,	Najlae Marass, Kamal Karouni,	Maroc Meteo	2
WdR, FaSi,	Wim de Rooij, Fabiola Silva,	KNMI Netherlands	3
		MET Norway	4
MaKo, BoBo, MaSz, GaSt,	Marcin Kolonko, Bogdan Bochenek, Małgorzata Szczęch-Gajewska, Gabriel Stachura,	IMGW Poland	16
JoRi, VaCo,	João Rio, Vanda Costa,	IPMA Portugal	4
SiTa, MiPi, AlDu, AlCr,	Simona Tascu, Mirela Pietrisi, Alina Dumitru, Alexandra Craciun,	Meteo Romania	4
MaDe, MaPe,	Maria Derkova, Martin Petras,	SHMU Slovakia	1.75
BeSt, JuCe, NePr,	Benedikt Strajnar, Jure Cedilnik, Neva Pristov,	ARSO Slovenia	6
NePr, NN1,	Neva Pristov, newcomerARSO1,	ARSO Slovenia/D	2
GeMo, JaCa,	Gema Morales, Javier Calvo,	AEMET Spain	6
HaBe, WaKh, HaDh, RaBR,	Haythem Belghrissi, Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	7
YeCe, MeSe, AlGü, FaBü, ZeÜn,	Yelis Cengiz, Meral Sezer, Alper Güser, Fatih Büyükkasabbaşı, Zeynep Feriha Ünal,	MGM Turkey	13

WP objectives and p

The goal of this work package is to assess the meteorological quality of ACCORD forecasting systems, and to identify needs for improvement and alleviation of weaknesses. Crucial activities needed to reach the goal are:
a) maintaining adequate verification of operational forecasts produced at the member institutes (MQA3.1, MQA3.3, MQA3.4)
b) performing meteorological assessments of updates to common cycles and pre-operational versions of ACCORD systems (e-suites) (MQA3.2, MQA3.3)
c) performing diagnostic studies and forecast experiments aimed at attributing causes to forecast errors (MQA3.3)
d) interaction with user communities, and facilitating the exchange between users and developers of the ACCORD forecasting systems (MQA3.4)

The puropse of verification is to assess the meteorological quality of forecasts. Ideally all aspects of a given forecasting suite should be verified. For a convection-permitting system this implies making use of spatially distributed data from satellites and radars, and analysed fields from suitable forecasting systems, as well as neighbourhood-sensitive metrics and measures describing the correspondence between observed and predicted fields. 3-D structures need to be accounted for, especially in relation to parameters related to clouds and michrophysics. In the context of an ensemble prediction system, it is essential to include probabilistic aspects. Verification of rare significant events like severe weather needs special attention, and may require collecting data over seasons or years. As forecast errors depend on factors such as geographical setting, weather type, season, time of day, or local topographic features, it is important to stratfy the verification statistics accordingly.

After technical testing (see COM3.1), updated versions of CSCs and operational implementations need to undergo thorough meteorological testing, covering all relevant weather types, climatic regimes, and types of landscape. In addition to point wise verification, 2-D and 3-D structures need to be assessed, especially in relation to clouds and microphysical processes. Differences in reults of new and pre-existing cycles should be described and understood. In order to detect compensating errors, that may be hidden in highly aggregated quality measures such as mean bias or rmse as function of forecasts lead time, the analysis of test runs should include diagnostic, process-oriented verification, focussing on distributions of variables in space and time, and the relationships between variables. A list of suitable cases and periods that can be used as test-beds for new developments needs to compiled, and data to support process oriented verification for these periods need to be collected and shared among the consortium.

Attributing causes to forecast errors is a complicated task, requiring expertise in modelling of dynamics and physical processes, use of observing systems, data assimilation, and post processing. Analysis of routinely collected verifiaction data is often not sufficient for error attibution, so additional diagnostic studies are usually required. Data and methods going beyond routine verification may be needed, and used for analysing operational output or dedicated case studies. Even in the absence of observations, a simple comparison of output fields from different systems can provide valuable insights.

The evolution of a numerical weather prediction system may be seen as a dialectic process where the needs of society pose scientific and technological challenges to be met by academic and institutional research, and where scientific advances make possible new or improved applications, that in turn generate new needs and pose new challenges. Accordingly, experiences and needs of operational users (e.g. forecasters, key users) throughout the consortium need to be collected, and allowed to influence the goals and priorities set for short-term and long-term development. Likewise, the user community must be kept informed about new possibilites offered by scientific developments.

Descriptions of tasks				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
MQA3.1	**Verification of operational systems:** Activities of this tasks include: routine production and analysis of verification and diagnostics from operational deterministic and probabilistic systems, monitoring of observation usage and impact, model comparison with other forecasting systems (global and/or regional) within routine verification or coordinated intercomparison studies, compiling and presenting verification reports, maintaining historical records of quality measures to monitor the longterm evolution of the system, as well as enhancing the scope of routine verification by adding new data and forecast parameters, and new quality measures and/or methrics.	SaChi, IsBo, ChWi, PhSc, FlWe, ClWa, NaAw, GeSm, JvdB, RMINe3, MiVa, AnSt, IrOd, EnKe, AhMe, CaFo, EeSa, InEt, CeLo, OlJa, AdNa, JMP, YaSe, ErWa, GhFa, JoSt, FaSt, VeLi, HeBe, LeLa, BeVi, BoTo, CoCl, EoHa, EoWh, JaFa, RóDa, FaSi, OlVi, EiSt, ÅsBa, MaKo, MaSz, GaSt, SiTa, MiPi, AlDu, AlCr, MaPe, BeSt, JuCe, NePr, GeMo, JaCa, HaBe, WaKh, HaDh, RaBR, YeCe, MeSe, AlGü, FaBü, ZeÜn,	Verification reports compiled and presented. New data types and metrics taken on board.		
MQA3.2	**Evaluation of updates and new cycles:** Planning, execution, analysis, and documenting of meteorological tests for updated versions of CSCs and operational implementations; selection and maintenance of test/benchmark cases representative for different weather regimes and situations, identification and collection of related observations.	WaCh, KnEi, ChWi, PhSc, FlWe, ClWa, NaAw, GeSm, IvVu, InEt, CeLo, OlJa, AdNa, JMP, YaSe, OlNu, ErWa, GhFa, JoSt, FaSt, YaPr, VeLi, HeBe, LeLa, BeVi, BoTo, CoCl, NaMa, KaKa, WdR, OlVi, EiSt, ÅsBa, BoBo, JoRi, VaCo, MaDe, GeMo, JaCa,	Evaluation reports, collection of test cases and inventory of related data sets for verification		
MQA3.3	**Error attribution:** Activities of this task include all necessary action to diagnose, analyze and alleviate persistent analysis and forecast errors, i.e. planning, conducting, and documenting of investigations into the causes and mechanisms behind such errors. Analysis of verification data, diagnostic verification covering selected periods and cases of interest, identifying and collecting relevant research data, experimentation and model intercomparison in full 3-D or 1-D mode, making use of diagnostic utilities such as DDH and research data, organizazion and participation in meetings and ond other forms of collaboration, e.g within ad hoc expert teams devoted to alleviating identified errors,	ChWi, ClWa, NaAw, GeSm, MiVa, FaSt, YaPr, EmGl, FaSi, GeMo, JaCa,	Documentation of persistent errors, inventories of useful research data		
MQA3.4	**User feedback and interaction:** Activities of this task include collecting, analysing and documenting feedback from the Members (or groupings of Members) concerning the quality of their operational forecasts, in particular views on systematic errors, remarkable forecast failures or success cases, judgment of bench forecasters and key users, and adaptations needed for the local context, organizing and participating in user meetings, managing and providing response to the user feedback, and in general keeping the user community informed regarding the status and plans for ACCORD systems.	ChZi, GeSm, IvVu, EeSa, AlHa, NePr, NN1, GeMo, JaCa,	Feedback collected Feedback summaries User meetings (e.g. by groups of Members)		

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	0.25
REK,	Ryad El Khatib,	Météo-France	3
MaKa, RiJa,	Martynas Kazlauskas, Rimvydas Jasinskas,	LHMS Lithuania	6.5
OlVi,	Ole Vignes,	MET Norway	0.5

WP objectives and priorities

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 many 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 traditionally is little studied 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 or EnVar 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 (BSC) 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. BSC makes its basic scalability and performance evaluation tools available to the ACCORD community and provides training to system 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 SPTR). 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.

In the near future (2023-2024), the expected significant code re-factoring in preparation of code adaptation (SPTR) suggests to lower the priority on some fine-grain code optimization studies (such as related to interfaces, to loop management, to data ordering etc.). Indeed, many places in the ACCORD computational codes might be affected by re-factoring, making optimization efforts irrelevant when they do not take into account the outcome of re-factoring (typically, how the code will look like in near-future T-cycles).

Another area of interest is Single Precision (SP). Initiatives will be taken for drafting a mid-term plan for ACCORD, taking into account the plans at ECMWF and MF (for the global codes), the link with phasing (T-cycles), the priority w/r to configurations (which confs should receive a higher priority), testing (strategy, options etc.)

Descriptions of tasks

Task	Description	Participant abbrev.h	Type of deliverablei	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
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	Increase the efforts on understandign the differences single vs double vs mixed precision studies for cy46/cy48.Evaluate the use of SP as default configuration in Harmonie for EPS mode. Discuss the possibility of using SP or MP in Data Assimilation codes	DaSa, REK, OlVi,	Non-t-code		
SY1.5	Use of the outcomes from the HIRLAM-funded project with Barcelona Supercomputer Center about the Harmonie performance analysis and the training on June 2022. - Use of Extrae and Paraver for more regular analysis and possible effects of new codes on the computational efficiency. Evaluate the possibility of use this tool for the SPTR1 outcomes. - 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		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		non-t-code		
SY1.7	Further studies with single-precision versions of the NWP codes for the forecast models		t-code		
SY1.8	Explore and evaluate the possible effects of the Machine Learning techniques in several computational aspects: use of GPUs, use of Cloud Services like European Weather Cloud or AWS, data formats and data-as a-service-techniques		Report		

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	2
CoDa, EoWh, RóDa,	Conor Daly, Eoin Whelan, Rónán Darcy,	MET Eireann	4
BeUl, ToMo,	Bert van Ulft, Toon Moene,	KNMI Netherlands	3
OlVi, RoSt,	Ole Vignes, Roel Stappers,	MET Norway	1.5
RaBR,	Rahma Ben Romdhane,	INM Tunisia	1

WP objectives and priorities

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
SY2.1	Consult Hirlam services on agreements to run a Harmonie RCR for CY46	DaSa, CoDa, TrAs,	Non-t-code	other repo	
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, RóDa, BeUl, OlVi,	Non-t-code	other repo	
SY2.3	Test injection of observation data at ECMWF and operational platforms running RCR		Non-t-code	other repo	
SY2.4	Ensure platform equivalence between the Reference system at ECMWF and operational RCR platforms on meteorological aspects		Non-t-code	other repo	
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.				
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	RoSt,			
SY2.7	Arrange virtual or presential training Harmonie and its components for newcomers.				
SY2.8	Design and implement Harmonie CSC test in Davaï testing tool on ECMWF		Non-t-code	DAVAI-tests	
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	other repo	

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	CoDa,	Non-t-code	other repo	
SY2.11	More portable versions of harmonie: - Working on Containers using (rootless) for MUSC and Harmonie CY46/CY48		Non-t-code	other repo	
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.	TrAs,	Non-t-code	other repo	
SY2.13	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, RaBR,	Non-t-code	harp	

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	2
EmAh, KaHi, StRa, XiYa,	Emy Ahlerskans , Kasper Hintz, Stephan Rathmeyer , Xiaohua Yang ,	DMI Denmark/D	8
MaKa, RiJa,	Martynas Kazlauskas, Rimvydas Jasinskas,	LHMS Lithuania/D	5.75
YuBa, RoSt,	Yurii Batrak, Roel Stappers,	MET Norway	1.5

WP objectives and priorities

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
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).	DaSa,	Non t-code	other repo	
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		Non t-code	other repo	
SY3.3	Continue the scripting to cmake compilation environment and multi repository strategy	YuBa,	Non t-code	other repo	
SY3.4	Exploring the possibilities of isolate parts of the Harmonie scripting to be use as modules for a future common scripting and use them for discussion during the design phase of DEODE WP5 model engine	RoSt,	Non t-code	other repo	
SY3.5	Script modifications for OOPS namelist handling	RoSt,		other repo	
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	DaSa,	Non t-code	other repo	

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
FlWe,	Florian Weidle,	ZAMG Austria/D	2
AlDe,	Alex Deckmyn,	RMI Belgium	4
RMINe2,	RMI-Newcomer2,	RMI Belgium/D	2
BoTs, MiTs, KoMl,	Boryana Tsenova, Milen Tsankov, Konstantin Mladenov,	NIMH Bulgaria/D	8
DaSa,	Daniel Santos ,	DMI Denmark	1.75
AlMa, FlSu,	Alexandre Mary, Florian Suzat,	Météo-France	1.25
MaKa, RiJa,	Martynas Kazlauskas, Rimvydas Jasinskas,	LHMS Lithuania	5
RoSt,	Roel Stappers,	MET Norway	0.5
YS2,	NewcomerIPMA2,	IPMA Portugal/D	1
OlSp,	Oldrich Spaniel,	SHMU Slovakia/D	2
NN1, NePr, JuCe, MaLi, BeSt, NN1,	newcomerARSO1, Neva Pristov, Jure Cedilnik, Matjaž Ličar, Benedikt Strajnar, newcomerARSO1,	ARSO Slovenia/D	5

WP objectives and priorities

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.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
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).	AlDe, DaSa, YS2,	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		reports		
SY4.3	Create a working group to participate in the design phase of the scripting solution to be developed in DEODE WP5. Discuss with the WP5 team the potential interest for ACCORD and the need for an open and modular design that allows the extension of the solution functionalities to the current levels of scripting systems used in both research and operation.	FlWe, AlDe, BoTs, MiTs, KoMl, TrAs, RoSt, OlSp, NN1, NePr, JuCe, MaLi, BeSt,			
SY4.4	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).	DaSa, FlSu,	script		

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	
KrKr,	Kristina Kryžanauskienė,	LHMS Lithuania/D	0.75

WP objectives and priorities

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
NOREF1.1	Develop a weather-sensitive criminal investigation method.	**HePo**	**picture in front page of Time Magazine**		