A Consortium for COnvection-scale modelling Research and Development

Rolling Work Plan 2025

version of 21 Novembre 2024

Introduction to the RWP2025

The following pages of the RWP2025 contain the work package presentations of the ACCORD activity planned in 2025, 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 April 2024 (discuss main changes with respect to the RWP2024, 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 2024, the draft version was made available to the LTMs, in order for them to prepare their manpower commitments.

Management issues

MG and Support Team composition

Jana Sanchez from AEMET was officially nominated as Documentation Officer in the beginning of 2024. Jana has progressively started her DO activity (reported in the 2024 Report). She will continue to participate as DO in the ACCORD activities in 2025, with a progressive focus on the inventory of scientific documentation. She will also participate actively in the consortium’s main events (ASW, EWGLAM, the one or other WW).

The composition of the MG has remained stable in 2024, enabling for the first time in ACCORD to implement the work plans with a full MG over a complete yearly exercise. Given the very high and dedicated involvement of the MG in the preparation of the consortium's scientific strategy for 2026-2030, a few early elements of the new strategy proposal have been translated into the RWP2025. Some further explanations on the main changes between RWP2024 and RWP2025 follow below.

An overview on what external funded projects mean for ACCORD

A number of ACCORD teams are engaging into externally funded projects (national research funds, European Research programs, EU-funded such as Destination Earth etc.). They use this opportunity to increase their staffing including for tasks that are within the scope of the ACCORD goals and therefore are described in the RWP. The consortium benefits from these efforts and the associated work and results should be made visible and available to all ACCORD members.

For the sake of clarity, it is reminded that the manpower associated with external funding can be described in the yearly commitments provided by the LTMs. The committed figures for externally funded manpower are considered to be provided "in good faith". When the LTM considers that not all conditions are in place to safely commit a figure, then he/she can decide not to do so (because a contract isn't signed yet, because of national regulations regarding staff management, because of uncertainty in the recruitment process etc.).

For the registration of the realized manpower, per quarter, the current guideline is that the LTMs register both in-kind and externally funded manpower likewise, provided the tasks are within the scope of the RWP. When an LTM has good reasons to believe that he/she cannot register some externally funded manpower, then this is eventually left up to him/her (same sort of reasons as for the commitments in good faith - see above).

A few words on the drafting of the RWP2025

The MG has decided to adapt the structure of the RWP and of the WPs in just a few places. Gradually, it is expected that the description of the timeline for expected outcomes of tasks will be improved (while keeping in mind that in the RWP, a deadline for a realized task does not have the same meaning as a deadline for an expected Deliverable in a contract-based framework). Like in previous years, a significant planning effort has been undertaken this year (in 2024) for next year, involving the usual intensive interactions with the teams. The main places of adaptation of the RWP2025, with respect to its 2024 version, are:

- The working method transition and modernization WP **COM2.T** has been updated to acknowledge the progress made in the last year, and augmented with new tasks such as **COM2.T.8** (impact of ML on NWP workflows).
- The documentation WP **COM4** has been drafted with quite some more concrete content than in 2024, thanks to the arrival and the kickoff of the DO.
- The "Strategic Project of TRansversal" Area (**SPTR**) is renamed into the more explicit "**CRA**" for Code Refactoring and Adaptation.
- In MQA, the WP **MQA3** has been split into **MQA3** (assess model weaknesses, implement strategies to understand them) and **MQA4** (systematic verification).

- A new WP **MQA5** has been drafted in order to describe the intended work of prototyping an infrastructure (an environment) for making process-oriented and high-impact weather sensitive validation (this WP can be considered as a first concrete proposal in the direction of the 2026-2030 strategy on process-oriented validation).

A first draft version of the RWP2025 was made available to the LTMs in the very end of June, so that they could cross-check with their teams and provide feedback to the MG with questions, or with missing items. At the very end of August, the LTMs were asked to provide their manpower commitments to the RWP2025, using a dedicated table under the responsibility of the ACCORD/CSS.

Link of the RWP2025 with the 2026-2030 scientific strategy proposal

Some inspiration originating from the strategy preparation made its way into the RWP2025 drafting. The most striking impact probably is the new WP MQA5, where it is proposed to start prototyping what a future MQA-infrastructure fit for process-oriented and high-impact weather validation could be. The WP MQA5 is inspired by the proposals made in the draft scientific strategy for ACCORD's phase 2 under MQA.

Some other WPs or tasks come in reflection of the new draft strategy proposal, usually confirming trends where an increased effort is expected in 2025 (and then beyond). This holds for a number of the core scientific WPs (in dynamics, physics, surface, DA, EPS) as well as for CRA. In common activities (COM2) and system (especially SY4), some further adjustment of tasks might be necessary during the winter, in order to account for the continued discussion on key strategic elements needed for the enhanced common development environment proposed in the new strategy. Of particular interest will be elements related to the common scripting system and ancillary components of the stackflow.

Machine Learning and AI activities described in this RWP

ACCORD teams show an increased interest in studying ML techniques for use within our current systems. The purpose is then either to enhance the functions of an NWP component (by a statistical, data-based approach where a physics-based approach would be much too complicated) or to improve the numerical performance of a component (reduce its numerical cost). Thus, ML topics appear in a number of WPs and tasks of the RWP2025, especially in data assimilation and EPS, however also in relation to physics parameterizations and surface. This evolution is fully in-line with the content of the WG-ML portfolio (presented to STAC in May 2023). It is aligned with the decisions by the ACCORD Assembly of December 2023 (the combined use of AI/ML with our physics-based NWP systems was approved as a strategic component - aka "hybrid ML/NWP"). The list of WPs and tasks where ML appears is given hereafter for information:

- ***COM2.T.8***: impact of data-driven models in an NWP workflow
- ***DA9.1***: Develop overarching strategy for ML in DA in ACCORD, ensure flow of information between areas
- ***DA9.2***: Preprocessing and QC of emerging observation types
- ***DA9.3***: Modelling of statistical observation operators
- ***DA9.4***: Neural networks for emulation and/or enhancement (systematic errors, statistical

minimization, emulation of TL/AD, sampling of uncertainty and dynamical constraints
- ***DA9.5***: DA in latent space: (Variational) auto-encoders, latent space Ensemble filters, energy-based models
- ***DA9.6***: Data-driven forecast models: develop RS-based probabilistic precipitation nowcasting system, full LAM-driven weather forecast models
- ***DA9.7***: ML Infrastructure development
- ***PH1.7***: Towards emulation of turbulence and convection parameterization by stochastic and/or learned-by-data (LBD) approaches
- ***PH2.10***: ML to emulate/accelerate radiation
- ***PH3.10***: Learned-by-data approaches to improve microphysics parameterization (liquid cloud optics)
- ***SU5.2***: Soil maps correction
- ***SU5.6***: Hectometric scale cover map for Europe
- ***E6.1***: Apply flexible field ensemble calibration
- ***E6.3***: Develop/verify Arome-EPS calibration methods with random forests, neural networks etc
- ***E6.4***: Generation and downscaling of ensemble members by deep learning approaches (GAN, auto-encoders or diffusion-based models)
- ***E6.5***: Analog-based post-processing
- ***E7.1***: Identification, evaluation of convection objects, severe storms in ensemble outputs, using deep NN. Development of deep-learning-based clustering of ensemble members.
- ***E9.9***: Test parameter sensitivity in 1D-model using URANIE framework
- ***MQA5.2***: Analyze the needs of data-driven models in the MQA-prototype infrastructure

About the link with DEODE

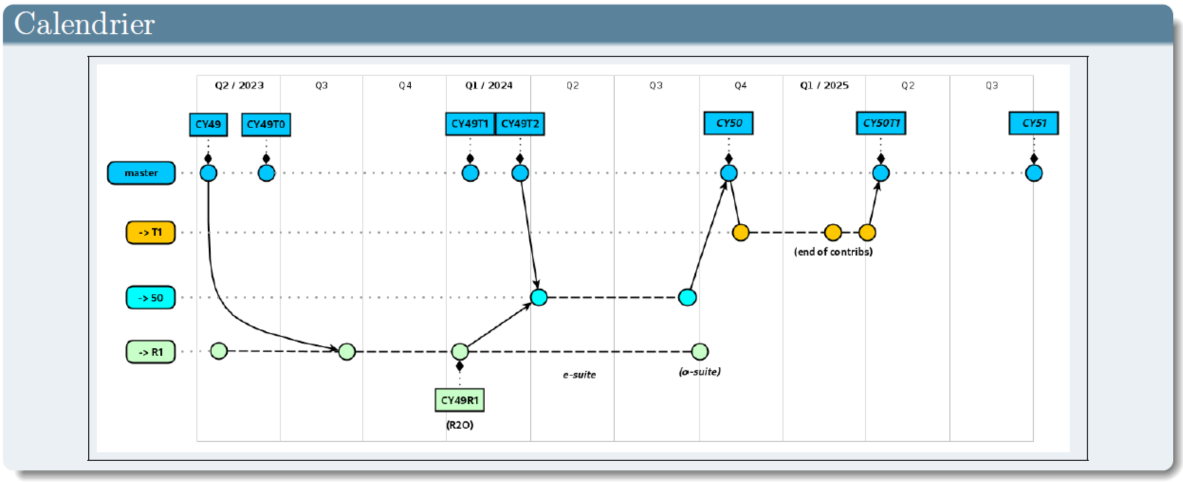
An extensive cross-analysis of the intersection of the ACCORD RWP with the DEODE work packages of phase 2, was presented to STAC in June 2024 (STAC7). The DEODE manpower figures (registration and commitments) currently are handled separately in the Common Manpower Register and in ACCORD's management work. In the RWP2025, the DEODE manpower figures are listed separately in the WPs, however the overall statistics of manpower shown in the graphics are with DEODE contributions included.

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.

Annexes appended on the following pages

Annex I: Provisional timeline of common code cycles next year

Blue: MF/ACCORD cycles. Green: ECMWF cycles. Cyan: synchronization (IFS-Arpege-LAM joint cycle phasing)



Annex II: Work packages and staff resources for 2025

For each Work Package, the total manpower committed for 2025 is given (1st column) and the estimated part of DEODE-funded manpower appears in column 2. Figures in person.months. In green the new items.

WP NUMBER		**WP NAME**	**TOTAL (person/ months)**	**estimated DEODE funded part**
MNGT	MNGT4	ACCORD Management	67.25	0
COM	COM2.1	Code generation and maintenance: regular maintenance and evolutions, official releases	46.25	0
	COM2.T	Code generation and maintenance: Transition to new work practices and environment	9.5	0
	COM3.1	Maintenance and Partners' implementations of the ACCORD system	66.5	1
	COM3.3	Training (preparation, lectures, attendance)	0.5	0
	COM3.4	Attendance and preparation of ASW & EWGLAM	14	0
	COM4	Common effort on documentation	5	0
Transversal software developments	CRA	Code Refactoring and Adaptation (formerly SPTR)	83.5	28

Towards modelling at (sub-)km resolution	HR	Sub-km modelling	65.5	27.5
Dynamics	DY1	Improvement of SISL spectral dynamical core (H and NH)	24.25	6
	DY2	FVM-like solution as an alternative to SISL dynamical core	7.5	3
	DY3	Development of methods for solving the implicit equation in gridpoint space	0	0
Data Assimilation	DA1	In-situ observations	39.25	0
	DA2	Use of ground-based remote sensing	57.25	0
	DA3	Satellite-based remote sensing observations	154.125	0
	DA4	Observation pre-processing, quality control, bias correction and representation error	41.5	1.5
	DA5	Variational systems, e.g. with 3D-Var or 4D-Var	57	0
	DA6	EnVar, EDA and variants	54.5	0
	DA7	Initialization methods and nowcasting	23.75	0
	DA8	Diagnostic methods, optimization of assimilation cycling	33	0
	DA9	AI/ML methods for data assimilation	20.25	4
Physics parameterizations	PH1	Turbulence & shallow convection	57.25	10
	PH2	Radiation	14	1
	PH3	Clouds-precipitation microphysics	55	2
	PH4	Common 1D MUSC framework for parametrization validation	2.75	0
	PH5	Model Output Postprocessing Parameters	32	0
	PH6	Study the cloud/aerosol/radiation (CAR) interactions	27.5	0
	PH7	On the interface between the surface and the atmosphere	11.75	1.5
	PH8	On the interface of Physics with Dynamics (and time stepping)	1.5	0
Surface analysis and modelling	SU1	Surface data assimilation	61	6.5
	SU3	SURFEX: validation and development of existing components for NWP	73.75	15.5
	SU4	SURFEX: development of new model components	8	0
	SU5	Assess/improve quality of surface characterization	28.25	14
	SU6	Coupling with sea surface/ocean	21	0
Ensemble forecasting and predictability	E6	Ensemble calibration by use of machine learning and deep learning algorithms	60.5	24
	E7	Develop user-oriented approaches	61.75	0
	E8	EPS preparation, evolution and migration	50	0
	E9	Model perturbations	47.25	6.5
	E10	Initial condition perturbations	5	0

	E11	Surface perturbations	10.25	0
	E12	Lateral boundary perturbations	9	0
Meteorological quality assurance and verification	MQA1	Development of HARP	13.75	2
	MQA2	Development of new methods for verification and validation	20.75	2
	MQA3	Model validation and error attribution	103.25	0
	MQA4	Verification of operational forecasts and user interaction	86.5	0
	MQA5	MQA-related Infrastructure	11.25	6
Technical code and system development	SY1	Code optimization	15.5	4
	SY2	Maintenance and development of the Harmonie Reference System	23.25	5
	SY4	Towards a more common working environment: explore practical choices, prototyping, scripting	43.5	26.5

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	10
MoMo,	Mohamed Mokhtari,	ONM Algeria	1
ChWi,	Christoph Wittmann,	GEOSPHERE Austria	1
AlDe,	Alex Deckmyn,	RMI Belgium	0.5
BoTs,	Boryana Tsenova,	NIMH Bulgaria	1
AnSt, MaTu,	Antonio Stanešić, Martina Tudor,	DHMZ Croatia	4.75
RuAn, ToBe,	Rune Andersen, Tommaso Benacchio,	DMI Denmark	1
IvAn,	Ivar Ansper,	ESTEA Estonia	1
ReEr,	Reima Eresmaa,	FMI Finland	1
ErBa, ErEs, CeLo, AlMa,	Eric Bazile,Eric Escaliere, Cecile Loo, Alexandre Mary,	Météo-France	10
GaSz,	Gabriella Szepszo,	HungaroMet Hungary	1
GNPe,	Guðrún Nína Petersen,	IMO Iceland	0.5
SaVa,	Saji Varghese,	MET Eireann	1
RiJa,	Rimvydas Jasinskas,	LHMS Lithuania	1
SiSb,	Siham Sbii,	Maroc Meteo	1
WdR, JeOn	Wim de Rooy, Jeanette Onvlee	KNMI Netherlands	6.5
BoBo,	Bogdan Bochenek,	IMGW Poland	1
MaMo,	Maria Monteiro,	IPMA Portugal	1
AlCr,	Alexandra Craciun,	Meteo Romania	1
MaDe,	Maria Derkova,	SHMU Slovakia	1
JuCe,	Jure Cedilnik,	ARSO Slovenia	1
JaCa,	Javier Calvo,	AEMET Spain	1
MaLi, MeSh, PaSa,	Magnus Lindskog, Metodija Shapkalijevski, Patrick Samuelsson,	SMHI Sweden	3
WaKh,	Wafa Khalfaoui,	INM Tunisia	1
YeCe,	Yelis Cengiz,	MGM Türkiye	1
LTMs	Local Team Manager	CHMI Czech	1
LTMs	Local Team Manager	MET Norway	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 execution of the yearly Detailed Action Plan (DAP), the implementation of the Consortium 5-year Strategy, the elaboration of the newsletter, 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	MoMo, ChWi, AlDe, BoTs, AnSt, MaTu, RuAn, ToBe, IvAn, ReEr, ErEs, CeLo, GaSz, GNPe, RiJa, SiSb, BoBo, AlCr, MaDe, JuCe, JaCa, MaLi, PaSa, WaKh, YeCe,			
MNGT4.2	Organisation, coordination, minutes of the GA, STAC, PAC, MG meetings	CSS,	preparatory documents, minutes & recommendations		
MNGT4.3	Elaboration and execution of the RWP, reporting to the GA	CSS,	RWP submitted to GA		
MNGT4.4	Preparation and execution of the annual budget	CSS,	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,	manpower submitted to GA		
MNGT4.6	Preparation and publication of the Consortium Newsletter	CSS,	2 publications/year		
MNGT4.7	Preparation and negotiation of co-operation agreements				
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	MaTu, AlMa, MaLi, MeSh, PaSa,			

MNGT4.10	Definition of the content of the CSCs and their monitoring. Address scientific and technical issues between the definition of the CSCs and the overall, transversal activity in each Area. Coordination within the CSC teams, link with transversal and topical coordination with PM+AL+IL	MaTu, MaLi, PaSa,			
MNGT4.11	Communication and coordination of operational changes of the common system (ARPEGE-AROME) in MF	CeLo,			
MNGT4.12	Coordination of the Consortium activities of their respective national project teams	ChWi, AlDe, BoTs, AnSt, RuAn, ToBe, IvAn, ReEr, GaSz, GNPe, RiJa, SiSb, BoBo, AlCr, MaDe, JuCe, JaCa, WaKh, YeCe,			
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)	MaTu,			
MNGT4.15	This task is to describe the work that will be asked to some of the ACCORD staff in relation to the preparation of the next phase ACCORD scientific strategy: - to participate in the strategy drafting team (people from the strategy workshop participants) NOTE: should the goal of completing and approving the strategy document be achieved in December 2024, then this task would drop, and no staffing would be required in 2025	MaTu,	scientific strategy document drafted in the summer 2024, presented to the Committees then to the Assembly in the end of 2024 (for approval)		
MNGT4.16	This task is to describe the work that will be asked to some of the ACCORD staff in relation to the preparation of the next phase ACCORD Memorandum of Understanding (MoU2): - to participate in the MoU2-WG, - to attend specific ACCORD Assembly meetings dealing with the progress of MoU2	MaTu,	MoU2 document drafted in the autumn/winter 2024-2025, regurlarly presented to the Assembly from the end of 2024 until spring 2025 (for approval)		

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
WaCh,	Walid Chikhi,	ONM Algeria	3
DaDe,	Daan Degrauwe,	RMI Belgium	0.5
DaSa,	Daniel Santos,	DMI Denmark	2
RyEl, StMa, AlMa, PaMo, ChPa, HaPe, PaSa, FlSu, FaVo,	Ryad El Khatib, Stephane Martinez, Alexandre Mary, Patrick Moll, Christophe Payan, Harold Petithomme, Patrick Saez, Florian Suzat, Fabrice Voitus,	Météo-France	27.75
CrRo, BeUl,	Chris Romick, Bert van Ulft,	KNMI Netherlands	3.5
YoKu,	Yogesh Kumkar,	MET Norway	3
OlSp,	Oldrich Spaniel,	SHMU Slovakia	2
DaYa, MaLi, MeSh, PaSa,	Daniel Yazgi, Magnus Lindskog, Metodija Shapkalijevski, Patrick Samuelsson,	SMHI Sweden	4.5

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 would be:
- preparation of code contributions 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.
- testing, technical validation of new code releases

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	Expected delivery (MM/YY)
COM2.1.1	**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)	WaCh, DaSa, AlMa, CrRo, DaYa, MaLi, MeSh, PaSa,	(1) planning and inventory documentation under the responsibility of the IL, (2) minutes of coordination meetings		continuous effort
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.	WaCh, DaSa, RyEl, AlMa, HaPe, FlSu, FaVo, MaLi, MeSh, PaSa,	New release CY51	IAL	31/08/2025
COM2.1.3	**Preparation of development branches** for the next T-cycle ARPEGE/LAM version, common to ACCORD. Includes: - Forward phasing of local branches (e-suites // H cycles, MF_op branches) to the latest common cycle - New developments (though redundant with Areas activities)	AlMa, CrRo, BeUl, YoKu, MaLi, MeSh,	Contributions to 50T1, 51T1	IAL	31/12/2025
COM2.1.4	**Build of an ARPEGE/LAM T-cycle release**, common to ACCORD. These are the cycles that will contain scientific and technical changes from the LAM groups (and from MF for ARPEGE). Includes Continuous Integration (CI) aspects : - the merge process and iterative validation - reviewing of other contributors branches - publication of release notes	WaCh, AlMa, HaPe, FlSu, FaVo, PaSa	New release CY50T1, 51T1	IAL	Q1/2025 (CY50T1), Q1/2026 (CY51T1)
COM2.1.5	**Technical validation:** - Maintenance of test system (Davaï): - adapting test bench to CSCs evolutions - introducing new tests (from CSCs, from Mitraillette, from ALs), incl. more integrated tests - automated analysis of outputs, visualisation dashboard - Porting to other platforms, incl. workstations - Coordination and reporting on Special Project SPFRACCO for computing resources dedicated to technical validation (testing) of contributions to a T cycle.	WaCh, DaDe, AlMa, PaSa, CrRo, YoKu,	New tested configurations: Harmonie-Arome 4DVar, SPP forecasts, ...	DAVAI-tests	continuous effort
COM2.1.7	**Tracking bugs/bugfixes** and phasing fixes among branches/releases.	AlMa,	IAL repo tickets & branches	IAL	continuous effort
COM2.1.8	Coordination on working practices in general, and on best practices for integration (as local support for the R&D staff). Organisation of an Accord System related WW	AlMa,	?		
COM2.1.9	**Track documentation in association with the codes** commits and Pull Requests (PR) in sight of Release Notes, re-evaluate relevance of PR templates, find improvements	DaSa, AlMa,	PR remplate update(s)		
COM2.1.10	**Externalisation of FA-LFI & LFA formats.** Pursue cleaning and refactoring of the formats source files, towards a clean API library, then formally externalised from the IAL.	WaCh, AlMa,	Removal branch in CY50T1 + FALFILFA repository	IAL	Q2/2025
COM2.1.11 (ex 2. T.1)	**Manage the ACCORD forge**, 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, AlMa,	A lively forge		continuous effort

COM2.1.12 (ex 2. T.3)	**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.	DaSa, AlMa,	Documentation		
COM2.1.13 (ex 2.T.	**Training about these tools/practices** Git (ACCORD forge), Davaï, bundling	DaSa, AlMa, CrRo,	Trainings sessions + supports		

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
WaCh,	Walid Chikhi,	ONM Algeria	1.5
AlDe, IdDe,	Alex Deckmyn, Idir Dehmous,	RMI Belgium	1.5
DaSa, HeFe, LeDe,	Daniel Santos, Henrik Feddersen, Leif Denby,	DMI Denmark	2.5
AlMa,	Alexandre Mary,	Météo-France	3
DaYa,	Daniel Yazgi,	SMHI Sweden	1

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 have set up 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 has been lead by the IL and the Sys-AL, in close connexion with the MG and other instances (ACCORD, MF, 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, differentiated 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 have been designed for this.

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 continue setting up new methodologies, work practices and environment for this purpose. It is a temporary work package, in that it describes the tasks to complete in order to achieve this transition.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
~~COM2.T.1~~ **> COM2.1.11**	~~**Manage the ACCORD forge**, 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)~~		~~A lively forge~~		~~continuous effort~~
COM2.T.2	**Bundled environment for the shared codes.** Follow the externalisations of codes in separate repositories (IAL, OOPS, Surfex, ...) and their gathering using the bundling tool from ECMWF (ecbundle). Adapt procedures (contribution, davaï, building versions, compilation) and publish documentation.	WaCh, AlMa,	Documentation + adaptation of tools	IAL-build	06/2025
~~COM2.T.3~~ **> COM2.1.12**	~~**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.~~		~~Documentation~~		
~~COM2.T.4~~ **> COM2.1.13**	~~**Training about these new tools/practices**~~ ~~Git (ACCORD forge), Davaï, bundling~~		~~Trainings sessions + supports~~		
COM2.T.5	**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.	DaSa,	Independant WIKI solution. A MF wiki-based solution is in place since 2021. Find an alternative solution by end of 2024 ?		12/2025
COM2.T.6	**Explore how an "all-CSC" export code version could be defined.** One key question is how to define an ACCORD-common effort on validation of a new code version at a level of component integration higher than what is done in 2023 (in sight of a local installation, towards operational use or use as a basis for contributions to an upcoming cycle). Discuss the definition of such a concept, then explore the technical requirements. First in a small WG and in MG, then communicate and get feedback from the teams.	DaSa, AlMa,	Descriptive note and communication of the paradigm to the teams		
COM2.T.7	**Capacity building for DAsKIT teams.** DAsKIT is the transversal project devoted to those teams who are in the process of building their knowledge and their capacity for running a full DA cycle in their home environment (on their local HPC). This task in COM2.T relates to the specific needs and efforts by the DAsKIT teams in order to install, run and validate all tools required to reach this goal: - install DA components, run a DA cycle with only surface assimilation (based on CANARI), assess its results (make diagnostics) - initial hands-on efforts and computatiuon of a first B-matrix for a home domain - install and run a full DA cycle (surface and upper-air), using the DAsKIT own scripting system & promoted tools, assess its results - provide support to other DAsKIT teams on these aspects - participate to the DAsKIT specific meetings, either online or in association with in-person DA WWs (prepare the presentations etc.) The tasks are organized and coordinated by the DAsKIT Coordinator, a member staff listed in the ACCORD Support Team who works in close collaboration with the DA AL. The role of the DAsKIT Coordinator is also referenced in this **COM2.T** WP. Note: all regular scientific or technical development work, such as computing a B matrix, preparing new sets of observations for DA or assessing the impact of a new option, should be desribed and reported in the relevant DA WP.	AlDe, IdDe,	reporting by DAsKIT teams during the DA WWs, during the DAsKIT specific online meetings, possibly within the ACCORD Newsletter		
COM2.T.8	**Impact of ML tools on NWP workflows.** Identify necessary adaptation required for ML tools and data-driven models in NWP forecast workflows for research and operational applications (R2O process-related). The goal of this task is to bring relevant people together in order to share across ACCORD their knowledge and/or open questions.	DaSa, HeFe, LeDe, DaYa,	reporting (from meetings, about analysis & design actions)		

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, AyMe,	Walid Chikhi, Ayoub Mehbali,	ONM Algeria	1.5
ChWi, FlWe,	Christoph Wittmann, Florian Weidle,	GEOSPHERE Austria	2.5
AnBu, AlTr, RaBr, PeJa,	Antonín Bučánek, Alena Trojáková, Radmila Brožková, Petr Janeček,	CHMI Czech	10.5
DaLa, PeEl,	David Lancz, Peter Elek,	HungaroMet Hungary	6
GNPe, BoPa, XiZh, KrGu,	Guðrún Nína Petersen, Bolli Pálmason, Xiaohui Zhao, Kristinn Guðnason,	IMO Iceland	6.25
OlVi, EiSt,	Ole Vignes, Eivind Støylen,	MET Norway	3
BoBo, PiSe, GaSt, MaSz, NaSz, MaKo, JaRo,	Bogdan Bochenek, Piotr Sekuła, Gabriel Stachura, Małgorzata Szczęch-Gajewska, Natalia Szopa, Marcin Kolonko, Jadwiga Róg,	IMGW Poland	13
VaCo, MaMo,	Vanda Costa, Maria Monteiro,	IPMA Portugal	0.75
MiPa,	Miguel Pardal,	IPMA Portugal/D	1
SiTa, AlCr, RaPo,	Simona Tascu, Alexandra Craciun, Raluca Pomaga,	Meteo Romania	7
MaDe, OlSp,	Maria Derkova, Oldrich Spaniel,	SHMU Slovakia	6
MaLi, MeSh, PaSa,	Magnus Lindskog, Metodija Shapkalijevski, Patrick Samuelsson,	SMHI Sweden	3
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	3
YeCe, ZeÜn, CeKı,	Yelis Cengiz, Zeynep Feriha Ünal, Celaleddin Kızılkaya,	MGM Türkiye	3

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, COM3.1.4 that only belong to the ToRs of CNA).

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.	PeJa, MaDe,			
COM3.1.2	"*Early*" installation of a new T-cycle version 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 **MNGT4.10**). Feedback needs to be provided to the ACCORD community (via CNA, via github, via Newsletter): - 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 work in one institute or by a 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 & testing of a Harmonie-Arome CSC Reference configuration (in link with **SY2**) - LACE: support provided by the LACE SCC or LACE Data Manager to other teams for their local installation - ACCORD teams otherwise: local installation of a T-cycle version and coordination via CNA "*early*": to be understood as *after* DAVAÏ testing (ie based on DAVAÏ outcomes - **COM2.1**) but *before* either adding options (codes) locally on top of a T-cycle and/or performing thorough meteorological testing to prove operational readiness.	WaCh, AyMe, ChWi, FlWe, GNPe, BoPa, XiZh, KrGu, BoBo, PiSe, GaSt, MaSz, NaSz, JaRo, MiPa, VaCo, MaMo, SiTa, AlCr, RaPo, MaLi, MeSh, PaSa, YeCe, ZeÜn, CeKı,	reports about installation of CY46T1 and CY48T3 export versions		

COM3.1.3	Coordination and communication of results of local installation and testing: - reporting on results of local installation, of troubleshooting and of solutions to problems encountered - collecting and sharing these results by several means (LTM meetings, newsletters, new communication tools in collaboration with the Documentation Officer - link with **COM4**)	AnBu, AlTr, RaBr, DaLa, PeEl, OlVi, EiSt, MaSz, MaKo, MaDe,	(1) updates for a bugfix branch (2) reporting in LTM meetings, or in newsletter, or in another communication device	IAL	2024
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	MaDe,	sensitivity studies using new LBC files from ARPEGE		

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, Martina Tudor and Daan Degrauwe**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
DaSa,	Daniel Santos,	DMI Denmark	0.5

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 IAL 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,	tutorial material		
COM3.3.4	Training on porting of ACCORD codes to heterogeneous hardware platforms: strategy, tools, good practices, coding rules		training 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
AlDe,	Alex Deckmyn,	RMI Belgium	0.5
AnSt, EnKe, MaTu,	Antonio Stanešić, Endi Keresturi, Martina Tudor,	DHMZ Croatia	1.5
DaSa, HeFe, ToBe,	Daniel Santos, Henrik Feddersen, Tommaso Benacchio,	DMI Denmark	1.5
IvAn,	Ivar Ansper,	ESTEA Estonia	0.5
CSS, CeLo,	Anne-Lise Dhomps, Cécile Loo,	Météo-France	2
GaSz,	Gabriella Szepszo,	HungaroMet Hungary	1.5
GNPe, BoPa, XiZh, KrGu,	Guðrún Nína Petersen, Bolli Pálmason, Xiaohui Zhao, Kristinn Guðnason,	IMO Iceland	2.5
SiTa, AlCr, RaPo,	Simona Tascu, Alexandra Craciun, Raluca Pomaga,	Meteo Romania	1.5
MaDe, MBell, OlSp,	Maria Derkova, Martin Bellus, Oldrich Spaniel,	SHMU Slovakia	1.5
JuCe,	Jure Cedilnik,	ARSO Slovenia	1

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)**
COM3.4.1	Preparation of the meeting (venue or online and programme)	MaTu, CSS, GaSz,	programme, list of participants, any published information or organisational note about the venue		
COM3.4.2	Preparation and presentation of national poster	AlDe, ToBe, CeLo, GaSz, SiTa, AlCr, RaPo, MBell, JuCe,	national poster		
COM3.4.3	Attendance	AlDe, AnSt, EnKe, MaTu, DaSa, HeFe, ToBe, IvAn, CeLo, GaSz, GNPe, BoPa, XiZh, KrGu, SiTa, AlCr, RaPo, MaDe, MBell, JuCe,			
COM3.4.4	Preparation of Newsletter contribution	AlDe, GNPe, BoPa, XiZh, KrGu, SiTa, AlCr, RaPo, MBell,	newsletter contrib.		

ACCORD WorkPackage description : COM4

WP number	Name of WP
COM4	Common effort on documentation
WP main editor	**Claude Fischer, Jana Sanchez**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
DO	Jana Sanchez / Documentation Officer	AEMET Spain	4
PM	Claude Fischer	(not relevant)	
CSS	Anne-Lise Dhomps	Météo-France	
MaTu,	Martina Tudor,	DHMZ Croatia	1

WP objectives and priorities

Documentation was recognized as a weak aspect in our consortium: too little efforts on producing it, too heterogenous organization of the existing one, sometimes lack of pertinent material for meeting the needs by the teams. In 2021-2022, the ACCORD/MG identified these issues and defined a set of meaningful levels of documentation:

1. close to the codes and the code commits (ie the information that has to be provided for the pull-request in the ACCORD source forge under GIT)
2. scientific-technical doc on a piece of code or an option in the code (in the spirit of the IFS documentation, including practical info such as range of validity of parameters)
3. practical guide: with the practical explanation on how to configure and use the new codes (documented namelists, users' guides)
4. meteorological validation: addressing isolated testing of the changes and comparisons in a complete model environment with a reference (experimental and/or during handover to operations)
5. scientific papers: peer-reviewed articles, ACCORD newsletter articles or internal notes made available to the consortium (where changes are scientifically justified)

The goals of this WP are to progressively reorganize the existing documentation and produce new one in a consortium-wide organization (formats, access, tools). The associated work plan will be organized by the DO appointed by the ACCORD Assembly in late 2023.

It is very worthwhile to mention that the efforts on documentation will span over all activities and tasks organized by ACCORD. Indeed, **"to design and to produce documentation" has to be seen as an implicit sub-task in any new development or to improve an existing one**. This will require **a change of culture in the consortium**. Therefore, the tasks and the manpower related to producing any of the five levels of documentation by the staff is generally not included in this WP COM4. It will be implicitly included in any of the relevant tasks of the other WPs of the RWP. An exception could be any specific task required by the ACCORD/MG or the DO, for staff to participate in the production or the organization of documentation in addition to their usual other tasks in the RWP.

In addition to documentation per se, we also will investigate tools to enhance communication and information across the consortium. Referencing existing documentation also will be more pertinent and useful when shared across all major NWP partners for ACCORD R&D (ECMWF, MF, the families, other research groups whose codes we are using).

Specific choices requiring a consortium-level decision on resources, will be brought up at the ACCORD Committees and the Assembly.

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)**
COM4.1	The tasks of the DO (summary of the ToR of the position): 1. organization of existing and new documentation 2. support to the elaboration of new documentation 3. support to the maintenance of an inventory of the documentary funds, including the link with IFS (ECMWF) and Arpege (Météo-France) 4. support to the organization of documentation required by specific management activity in the consortium, as coordinated by MG 5. provide support to the ACCORD/CSS on the elaboration of the consortium Newsletter, and on documentation hosted in the consortium website 6. provide support to the PM or to MG members on the elaboration of communication and publication material	DO	The DO activities will be reported at the ACCORD All Staff Workshop and in the Newsletter, as well as in the scientific reporting as felt relevant.		
COM4.2	This task is for any ACCORD staff who will perform specific work in connexion to the organization and production of documentation, upon (kind) request by the ACCORD/MG or by the DO. This task does not include documentation efforts directly related to scientific or technical development (this effort is an implicit, however very encouraged part of the general R&D activity and thus to be kept in mind in any regular task of the RWP).	MaTu			
COM4.3	This task is about organizing documentation according to their category and by exploring suitable devices (eg webpages, wiki etc.)	DO, CSS, PM	At least one device for hosting and organizing documentation has been explored, including comparing with existing devices. A report is made available.		
COM4.4	This task is about organizing documentation across the NWP collaboration and sharing a common referencing with ECMWF, MF and other ACCORD families (eg LACE, Hirlam/UWC)	DO, PM, MaTu	At least one joint meeting with ECMWF and MF doc representatives has taken place		
COM4.5	This task is about the exploration and the testing of suitable communication tools	DO, CSS, PM	At least one communication tool has been tested and reported on		

ACCORD WorkPackage description : CRA

WP number	Name of WP
CRA	Code Refactoring and Adaptation (formerly SPTR)
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	4.5
DeHa, DaDe,	Denis Haumont, Daan Degrauwe,	RMI Belgium/D	16
MaTu,	Martina Tudor,	DHMZ Croatia	1
ErCo, SeRi, PhMa, NiPe, ErSe, QuRo,	Erwan Cossevin, Sebastien Riette, Philippe Marguinaud, Nicolas Penigaud, Eric Sevault, Quentin Rodier,	Météo-France	24
JuGr,	Judicël Grasset,	Météo-France/D	11
AlMc, EnBr, JoPa, OiRo,	Alastair McKinstry, Enda O'Brien, Jospeh Parker, Oisin Robinson,	MET Eireann	22
BoBo,	Bogdan Bochenek,	IMGW Poland	4
PiSe,	Piotr Sekuła,	IMGW Poland/D	1

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 efficient hardware-specific 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 GPUs. 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 (FIELD_API) and a cleaning and refactoring of the control layer routines (CRA1). For the spectral transforms, which are well-delineated and slowly-evolving, yet crucial for performance, a manual hardware-specific porting and optimization is targeted (CRA2.1). For the case of the physics parameterizations, which cover a large part of the code base of the forecast model, and which are evolving much faster than e.g. the spectral transforms, source-to-source transformation tools will be developed (CRA2.2) and applied to the individual parameterizations (CRA2.3).

A different strategy to develop an NWP model that is portabile to hetereogeneous architectures is through the use of a Domain-Specific Language (DSL). ECMWF is developing the finite-volume model PMAP with the GT4Py DSL. While the capabilities of this model in terms of scientific questions like stability over steep slopes is investigated in DY2, the performance and portability of this approach are evaluated in this work package (CRA3)

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 CPUs does not degrade. An extension of the regular testing platform of ACCORD, Davai, in these directions will be investigated.

The phase 2 of the Destination Earth Extremes On-Demand (DE_330) project contains a task (WP10.2) on code adaptation to EuroHPC infrastructure. Care was taken to align the DE_330 WP10.2 with this ACCORD rolling workplan.

NOTE: The name of this WP has been changed from "SPTR" to "Code Refactoring and Adaptation" (CRA) in order to make it more explicit on its goal and content.

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)
CRA1	**Prepare ACCORD codes for porting to GPUs.** 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 to improve the flexibility of the code in terms of which part of the model runs on which device. At the level of the control routines, this is achieved by a consistent introduction of FIELD_API structures throughout the forecast model code. Regarding the gridpoint computations, 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. The strategy to achieve this flexibility is to use source-to-source translator scripts to automatically generate the finely granular layout from the familiar coarsely granular layout. These scripts take care of the correct dimensioning of arrays, correct placement of NPROMA-block loops, wrapping of temporary arrays in FIELD_API structures. A proof-of-concept of this strategy to has been developed and tested for ARPEGE and ALARO. Further work is needed on the control routines of the AROME and HARMONIE-AROME configurations. The existing (perl) source-to-source translator scripts are being rewritten in the more future-proof Loki (python) framework.	DeHa, DaDe, MaTu, ErCo, JuGr, SeRi, PhMa, NiPe, ErSe, QuRo, BoBo,	t-code	IAL	
CRA1.1	**Furter development of FIELD_API.** This library is being developed very actively and novel features are being introduced to improve the performance. Testing will be done on different hardware platforms, such as AMD GPUs or NVIDIA Grace Hopper. Any progress on the integration of FIELD_API with the Atlas library will be closely monitored.	ErCo, JuGr, PhMa, NiPe, ErSe,		other repo	
CRA1.2	**Refactoring of the AROME control routine and 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.	ErCo, JuGr, PhMa, NiPe, SeRi, QuRo,		IAL	
CRA1.3	**HARMONIE-AROME refactoring.** HARMONIE-AROME parameterizations overlap largely with (or at least follow the coding style as) the AROME parameterizations. The HARMONIE-AROME parameterizations need to be transformed along the same lines as those of SPTR1.1.			IAL	

CRA1.4	**ALARO refactoring.** A significant cleaning and refactoring of the ALARO control routines has been performed and entered cy49t1. Some diagnostic features have not been refactored yet (DDH, EZDIAG). Further refactoring may become necessary as more parameterizations are ported to accelerators.	DeHa, DaDe, MaTu, BoBo,		IAL	
CRA1.5	**Refactoring of other forecast model parts** that are necessary for the time integration. These include the semi-Lagrangian advection scheme, the gridpoint dynamics, the spectral dynamics and the LBC treatment.	DaDe,		IAL	
CRA1.6	**Refactoring of diagnostic computations** such as DDH and FullPos. This is considered to be less urgent, as such computations could stay on the CPU while the prognostic computations happen on the GPU.			IAL	
CRA2	**Porting of individual pieces of ACCORD codes to GPUs.** Profiling and tuning to enhance performance.	DeHa, DaDe,			
CRA2.1	**Porting of biFourier spectral transforms.** A working version of the spectral LAM transforms already exists for both NVIDIA and AMD GPUs. An integration of the GPU-ported LAM transforms with the global transforms is envisaged. The possibility of a FIELD_API-based interface will be investigated.	DeHa, DaDe,	t-code	other repo	
CRA2.2	**Development of source-to-source translator tools.** Gridpoint column calculations (mainly physical parameterizations, but also some dynamics) will be ported using the Loki source-to-source transformation tool. While various CPU-to-GPU recipes already exist in Loki, further investigation and development of ACCORD-specific features in Loki will be carried out. It will be investigated if the existing recipes can be applied to the ACCORD physics parameterizations and if they deliver good performance on different hardware platforms. If needed, the recipes will be modified or new recipes will be created within Loki.			other repo	
CRA2.3	**Application of source-to-source translator tools.** Porting to GPUs 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. For physics parameterizations that are not part of PHYEX (e.g. ALARO parameterizations), stand-alone drivers will be created along the way as the porting to GPUs progresses.			IAL	
CRA2.4	**Porting of the semi-Lagrangian advection scheme to GPU.** This was already done for the global model ARPEGE; adaptation and testing of these developments for the LAM case will be carried out.	DaDe,		IAL	
CRA3	**Exploration of performance portability of the GT4Py Domain-Specific-Language (DSL).** This DSL is focusing on stencil-based numerical schemes. A LAM version of a GT4Py-based finite-volume model (PMAP) is under development at ECMWF. In ACCORD, these developments will be monitored and the performance portability will be tested on various hardware platforms. Also the conversion of (a subset of) ACCORD physics parameterizations to a GT4Py-compatible version will be explored.	DeHa, DaDe,	report		
CRA4	Introduce ECMWFs **multIO IO server** in the ACCORD configurations.		t-code	IAL	
CRA5	**HPC access, testing and integration.** Seek to get access to a diversity of platforms (NVIDIA GPUs, AMD GPUs, Intel GPUs, ARM processors, vector accelerators) and perform experiments on these platforms using the stand-alone drivers of CRA2.1 and CRA2.3. The pieces of code that have been ported to accelerators (CRA2) will be integrated into the full model and their performance will be evaluated. The source-to-source transformation tools developed in CRA2.1 will be integrated in the ACCORD build system(s) (gmkpack/cmake). During the refactoring (CRA1) and the porting to accelerators (CRA2), 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.	PiSe,	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
ChWi, PhSc, ClWa,	Christoph Wittmann, Phillip Scheffknecht, Clemens Wastl,	GEOSPHERE Austria/D	4.5
MaTu,	Martina Tudor,	DHMZ Croatia	1.5
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech	3
RaBr, JaMa, PeJa,	Radmila Brožková, Ján Mašek, Petr Janeček,	CHMI Czech/D	4.5
ToBe,	Tommaso Benacchio,	DMI Denmark/D	2
SaAn, ErBa, DiRi, NiMe, LoLu,	Salome Antoine, Eric Bazile, Didier Ricard, Nicolas Merlet, Louis Lutun,	Météo-France	9.25
LeRo,	Leo Rogel,	Météo-France/D	5
BoPa,	Bolli Pálmason,	IMO Iceland	1
XiZh,	Xiaohui Zhao,	IMO Iceland/D	0.5
CoCl, EoWa,	Colm Clancy, Eoin Walsh,	MET Eireann	5.75
CoCl,	Colm Clancy,	MET Eireann/D	3
NaMa, Hakh,	Najlae Marass, Hafsa Khaye,	Maroc Meteo	12
NaTh,	Natalie Theeuwes,	KNMI Netherlands	2.5
WdR,	Wim de Rooy,	KNMI Netherlands/D	4
NaSz,	Natalia Szopa,	IMGW Poland	2
AnSi,	Andre Simon,	SHMU Slovakia	1
GuHa, PaSa, SwMa,	Gunther Haase, Patrick Samuelsson, Swapan Mallick,	SMHI Sweden/D	4

WP objectives and priorities

The main objective is to achieve up-to-date, realistic and affordable versions of sub-km AROME-France, HARMONIE-AROME and ALARO. Research extends to the hyper-resolution scale (ie O[100-200m] horizontal resolution in grid point space). There is a clear link with 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, 3D aspects;
- 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 at these VHR grid scales and grid sizes.

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 (from within **DA1-2-3**) and suitable new validation and verification techniques for hyper-resolutions (**MQA2**). In addition, options for initialization and computational efficiency will be addressed. Options for data assimilation settings and ensemble configurations will also be taken into consideration, however with some less priority. 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). LES data will be considered especially in the context of idealized cases. 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 **DY** 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 impact of how the VHR models are being initialized will be checked (is any "warm-up" phase useful ?).

The list of tasks below is the outcome of discussions by the ACCORD/MG and in association with the WG-VHR. The tasks are organized along four main packages:
- HR1: studying the scientific added value
- HR2: studying the impact of surface conditions
- HR3: studying the numerical stability aspects
- HR4: preparing a shared experimental environment on ECMWF's ATOS platform

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)**
HR1.1	evaluate the VHR models on idealized cases, including the use of diagnostic tools like DDH, MUSC, comparison with an LES model (for boundary layer flows, for clouds etc.) The use of the DDH accross the CSC depends on the **PH8.6** task and wil benefit from the task **PH5.1.3**	ErBa, LeRo, Hakh, V	reports, namelists		
HR1.2	evaluate the VHR models on real cases, using diagnostic tools, comparison with LES, with observations. Use new tools and new types of observations prepared by the MQA Area (harpSpatial for instance)	ChWi, PhSc, ClWa,	reports, namelists		
HR1.3	for real case use cases, including field campaigns: make relevant observations available to other teams or describe how these observations can be accessed, search for or participate in creating LES data	DiRi, WdR, NaTh,	reports or documentation on how to access an archive of observations; archives of obs or LES data		
HR1.4	as a particular topic of interest, assess the impact of 3D effects in turbulence (link with **PH1.3-PH1.4**) and/or radiation (**PH2.11**)	MaTu, RaBr, JaMa,	reports, namelist configurations		
HR1.5	prepare new test cases for both 500m and 200m grid mesh resolution (link with **SU3.3** regarding urban modeling and using TEB if relevant for the geographical area and the chosen domain)	NaTh, PaSa,	documentation on the test cases (reports)		
HR1.6	for collaboration across ACCORD teams, consider making available the relevant input data and output results (PGD files, IC/LBC files, model output files, log files, output of diagnostic tools). Make these data available preferably on the ECMWF ATOS platform. We recommend to make the data available under the following archiving structure (to be done by each team): - clim files, PGD files, IC files, surface IC files (PREP output), LBC files, namelists, model output historical files, postprocessed files, diagnostic outputs such as DDH	MaTu,	data archives (to be organized and made accessible by each team). The recommended platforms are ECMWF (preferred) and MF.		

HR2.1	define use cases where surface conditions are assumed to have an important impact, especially for heterogeneous surface conditions. Describe the way the PGD files have been computed	NaTh, GuHa, SwMa	report; doc and access to input data (see **HR1.6**)		
HR2.2	study the impact of using different input physiography files, of defining a different truncation for orography	SaAn, ErBa, BoPa,	report		
HR2.3	compare with HR local surface data sets, assess the subgrid variability of physiography fields from local very fine scale data sets (link with **SU5.6**)		report; databases		
HR3.1	when numerical instability is suspected (from log files, from a noisy aspect of plotted fields, from model crashes), study the impact of options in dynamics or from how the model is initialized (use of DFI etc.). Perform these sensitivity experiments in close coordination with dynamics experts. Links or some overlapping tasks may be expected with Dynamics WP DY1, like for instance **DY1.4-DY1.5-DY1.6-DY1.7** .	PeJa, ToBe, NaSz,	report		
HR3.2	assess the model behavior on the specific case of the 200m grid mesh resolution over complex orography. Some links with DY1 WP tasks might be expected (see above).		report		
HR4.1	in order to make available a simple, common experimental environment to many ACCORD teams, build a common environment containing: - a very recent code version (eg CY48T3), the associated binary executable files, - a set of IC/LBC files to run one or two reference experiments, the associated namelists for one or several VHR configurations of CSCs, - a plain script handling input and output workflow for a single forecast. This task will be done keeping in mind the development of dedicated scripts for DEODE. The relevance and use of the DEODE scripts will be analyzed in a later stage, in collaboration with the DEODE management and the ACCORD MG (link with **SY4**).		report, non-t-code	?	
HR4.2	assess the correct execution of single (ie mixed) precision runs on VHR use cases, in close coordination with the CSC teams (link with **SY1.3**)		report, t-codes	IAL	

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
PtSm,	Petra Smolíková,	CHMI Czech	6
PtSm	Petra Smolíková,	CHMI Czech/D	3
LuAu, HaPe, FaVo, SyMa,	Ludovic Auger, Harold Petithomme, Fabrice Voitus, Sylvie Malardel	Météo-France	9
CoCl,	Colm Clancy,	MET Eireann	0.25
NaSz,	Natalia Szopa,	IMGW Poland	2
AlCr,	Alexandra Craciun,	Meteo Romania	1
NiKa,	Nika Kastelec,	ARSO Slovenia/D	3

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

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)
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.	PeSm, FaVo, NaSz,	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. This code is available on top of cy46T1 for constant control parameters. These new options will be tested on very high resolution domains. It is planned for the DE_330 project.	PeSm, NiKa,	t-code, non-t-code		
DY1.4	Optimal initialization methods to dampen oscillations or spin-up at very high resolution. Using operational hectometric resolution configurations in dynamical adaptation mode will require the use of initial filtering tech based on the techniques that were used before the introduction of data assimilation in our local area models. This will be particularly relevant in the context of the DE_330 project where 500m and 200m are a target resolution.	PeSm,	t-code, non-t-code		
DY1.5	Adaptation of vertical levels distribution for higher resolution domains such as 200m and 500m resolution in the context of DE_330 project.	LuAu,	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	PeSm,	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, FaVo, SyMa,	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.	HaPe, FaVo, SyMa,			

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
ToBe, OlLi,	Tommaso Benacchio, Ole Lindberg,	DMI Denmark	3
ToBe, OlLi,	Tommaso Benacchio, Ole Lindberg,	DMI Denmark/D	3
FaVo,	Fabrice Voitus,	Météo-France	1.5

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
DY2.1	On the basis of the latest DSL-based FVM version, a testing of FVM will be performed. This last version is already operating on a local area domain but works on ideal cases. Now we want to focus on the comparaison in term of stability with the ACCORD model in particular on very high resolution with realistic orography. Different components of FVM might be of less interest for us (for instance the transport scheme).	ToBe, OlLi, FaVo,	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	In-situ observations
WP main editor	**Benedikt Strajnar, Helga Toth, Kasper Hintz**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
IsLa,	Issam Lagha,	ONM Algeria	2
BoTs, MiTs,	Boryana Tsenova, Milen Tsankov,	NIMH Bulgaria	4
KaHi, EmAl,	Kasper Hintz, Emy Alerskans,	DMI Denmark	2.5
ErGr,	Erik Gregow,	FMI Finland	2
ViPo, AlDe	Vivien Pourret, Alan Demortier,	Météo-France	12.5
DaLa, HeKo, PeEl,	David Lancz, Helga Kollathne Toth, Peter Elek,	HungaroMet Hungary	5.5
ZaSa, FaHd,	Zahra Sahlaoui, FatimaZahra Hdidou,	Maroc Meteo	4
MaMo,	Maria Monteiro,	IPMA Portugal	0.25
MaDe,	Maria Derkova,	SHMU Slovakia	1
MaDi,	Maria Diez,	AEMET Spain	1.5
MaLi,	Magnus Lindskog,	SMHI Sweden	1
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	3

WP objectives and priorities

LAM data assimilation relies on existing traditional conventional in-situ observations to a large extent. One of the basic goals of this package is to ensure their optimal use and evolution in terms of extended data provision (such as high-resolution and descent radiosonde data, high-resolution national automatic meteorological station networks, humidity from aircraft, growth of Mode-S derived aircraft observations). Furthermore, significant opportunities are offered by crowd-sourced in-situ observations from private weather stations, smartphones and other IoT devices with weather-related sensors. These observations might need new approaches to data selection, QC and thinning (link with DA4), possibly powered by ML/AI (link with DA9).

Top priorities:
(1) Enhance use of Mode-S EHS observations.
(2) Prepare data flow and methodologies to use crowd-sourced in-situ observations.
(3) Ensure full exploitation of high-resolution radiosondes.

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)**
DA1.1	**Assist local implementation of high-resolution ascent and decent radiosondes and wind profilers:** optimize local pre-processing, extend observation operator, assess the quality and perform impact study.	DaLa, MaDe, WaKh, HaDh, RaBR,	T-codes and scientific note.		
DA1.2	**Surface observations (Ps, T2m, Hu2m, V10m):** Perform impact assessment of high-quality and high-resolution SYNOP DA; promote data exchange of local high-quality observations between NMS's.	IsLa, BoTs, MiTs, HeKo, ZaSa, FaHd, MaMo, MaDe, WaKh, HaDh, RaBR,	T-codes and scientific note		
DA1.3	**High-resolution crowd-sourced surface observations (surface pressure, T2m, q2m, V10m):** Further explore the potential of volunteered observations from crowdsourced, private weather stations, cars, unmanned aerial vehicle (UAV), 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; evaluation and implementation to the operational AROME-France	KaHi, EmAl, ErGr, ViPo, MaLi, AlDe	Codes and scientific note		
DA1.4	**Aircraft-based observations:** 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; coordinate with EMADDC to provide and validate rapidly available Mode-S datasets suitable for systems with a short cut-off; impact assessment in 3D-Var and 3D-EnVar.	ViPo, PeEl, MaDi,	T-codes and scientific note		
DA1.5	**Observations from balloons:** wind data from recreational hot-air balloon flights in HARMONIE-AROME; data from other campaigns; introduce new obstype for balloon measurements.	ViPo,	Code, scientific note and technical documentation		

ACCORD WorkPackage description : DA2

WP number	Name of WP
DA2	Use of ground-based remote sensing
WP main editor	**Benedikt Strajnar, Jana Sanchez Arriola, Maud Martet**

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	1.5
FlMe,	Florian Meier,	GEOSPHERE Austria	2
IdDe,	Idir Dehmous,	RMI Belgium	2
AnBu, AlTr,	Antonín Bučánek, Alena Trojáková,	CHMI Czech	4
MaDa,	Mats Dahlbom,	DMI Denmark	2
MaMa, JeOt, PaMo, DoRa,	Maud Martet, Jeremy Ottaviano, Patrick Moll, Dominique Raspaud,	Météo-France	18.25
LaMa, HeKo,	Laura Magyar, Helga Kollathne Toth,	HungaroMet Hungary	7
FaHd,	FatimaZahra Hdidou,	Maroc Meteo	2
SvdV, MiKo,	Sibbo van der Veen, Michal Koutek,	KNMI Netherlands	3
MiNe, MPtc,	Michal Nestiak, Martin Petrovic,	SHMU Slovakia	5
PeSm,	Peter Smerkol,	ARSO Slovenia	2
JaSa,	Jana Sanchez,	AEMET Spain	2
MaRi, GuHa, BeRy,	Martin Ridal, Gunther Haase, Bengt Rydberg,	SMHI Sweden	6.5

WP objectives and priorities

The general goal is to optimise the use of ground-based remote sensing observations from currently used sources and networks, such as radar, GNSS and wind profilers. In addition, we aim to explore new products from existing and new networks. Examples of such new products are GNSS slant delays (SD) and horizontal gradients (HG), and they are to be compared with use of zenith total delays (ZTD). Also more investigation of the use of radar wind information and the dealiasing methods, and the use of cloud and hydrometeors from radars and precipitation-related observations from microwave links would be needed. About new observation networks, one aim is to explore the real time GNSS Observations than are delivered by some of the Analysis Centres that can be very beneficial in Nowcasting. These kind of remote sensing and ground-based observation usage will be for all DA systems (Var, En-Var) and for MASTERODB and OOPS versions. A close collaboration with OPERA and E-GVAP is foreseen important to ensure optimal use of their products.

Top priorities:
(1) Assimilation of both radar reflectivities and winds and optimize its way to do it according with each country radar data general characteristics.
(2) Prepare and explore the use of various GNSS products and their use in shorter cut-off and nowcasting systems.
(3) Exploration of new ground based remote sensing products available and perform a comparison of all of them.

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	**Assist local implementation of radar data assimilation:** optimize radar assimilation, adaptation/adjustment to new changes of radar data characteristics for operational use; continue to harmonize and improve the quality control procedures and pre-processing (intelligent thinning / super-obbing); test alternative velocity dealiasing algorithms and provide feedback to OPERA; generalize radar processing to various assimilation systems; impact studies to assess value of radar data in different weather regimes. Perform monitoring and assimilation of various radars from different European countries.	FlMe, AnBu, AlTr, MaDa, MaMa, LaMa, HeKo, MiKo, MiNe, MPtc, PeSm, JaSa, MaRi, GuHa,	T-codes and scientific note		
DA2.2	**Ground-based GNSS observations:** **-- further elaborate the assimilation of GNSS ZTD data: 1)** assimilation of GNSS ZTD data without or with less anchoring observations; **2**) refine white- or blacklisting of GNSS stations and use of VarBC; **3**) conduct impact studies ; **4**) Space-based GNSS observations: new GNSS-RO Receivers **5**) Update systems to real time ZTD GNSS observations **-- GNSS slant delay: 6**) further assist the implementation and porting process to the common code, conduct impact study with 3D/4D-Var; **7)** test feasibility and impact of InSAR delay data from Sentinel-1 with slant delay operator; **-- GNSS ZTD horizontal gradients: 8**) Perform impact studies with data provided by IGN.	MOAM, FlMe, PaMo, DoRa, HeKo, FaHd, JaSa, MaRi,	T-codes and scientific note		
DA2.3	**Rain-sensitive observations:** 1) *Attenuation in telecommunication microwave links due to rain:* Refine the preprocessing to efficiently separate dry and wet attenuation. Study suitable observation operators to assimilate retrieved rain rates (standalone physics package from P. Lopez and/or Latent Heat Nudging); 2) *Radar-based rain rate:* explore the same approach for assimilation of radar-based, measured or analysed rain rates (as done in Morocco); 3) Cloud- and precipitation-related radar products.	SvdV, GuHa, BeRy,	Codes and Scientific note		
DA2.4	**Lidar observations:** Investigate possibilities to assimilate lidar data	JeOt,	Codes and Scientific note		
DA2.5	**New technique for assimilating radar data:** 1) Direct assimilation of radar reflectivity: In context of OOPS and EnVar with the extended control variables to hydrometeor contents 2) Radar polarimetric data: assess more European OPERA data for assimilation in Arome-France.	MaMa,	T-codes and scientific note		

ACCORD WorkPackage description : DA3

WP number	Name of WP
DA3	Satellite-based remote sensing observations
WP main editor	**Benedikt Strajnar, Stephanie Guedj, Isabel Monteiro, Olivier Audouin**

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

Participant Abbreviation	Participant	Institute	PersonMonth
MOAM, ChBo,	Mohand Ouali Ait Meziane, Chahrazed Bouzerma,	ONM Algeria	3.5
AdNe, FlMe,	Adhithiyan Neduncheran, Florian Meier,	GEOSPHERE Austria	11
SuPa,	Suzana Panežić,	DHMZ Croatia	6
MaDa, FaBa, FaBa,	Mats Dahlbom, Fabrizio Baordo, Fabrizio Baordo,	DMI Denmark	2.5
ReEr, DaSch,	Reima Eresmaa, David Schönach,	FMI Finland	5
OlAu, MaBo, ThBu, ThCa, PhCh, ElCL, AnCh, PaCo, HéDu, NaFo, ChPa, ViPo, NiSa, XxXX,	Olivier Audouin, Mary Borderies, Thomas Buey, Thomas Carrel-Billiard, Philippe Chambon, Elisa Chardon-Legrand, Antoine Chemouny, Pauline Combarnous, Hélène Dumas, Nadia Fourrie,Christophe Payan, Vivien Pourret, Nicolas Sasso, Newcommer Gmap/Obs,	Météo-France	85.125
ZaSa,	Zahra Sahlaoui,	Maroc Meteo	2
IsMo, ErDe, GJMa, CrRo,	Isabel Monteiro, Erik Dedding, Gert-Jan van Marseille, Chris Romick,	KNMI Netherlands	14
StGu,	Stephanie Guedj,	MET Norway	1
MaDe,	Maria Derkova,	SHMU Slovakia	0.5
BeSt,	Benedikt Strajnar,	ARSO Slovenia	2
MaDi, JoCa,	Maria Diez, Joan Campins,	AEMET Spain	7.5
MaLi, RoSc, NiHa, BeRy, SwMa,	Magnus Lindskog, Ronald Scheirer, Nina Håkansson, Bengt Rydberg, Swapan Mallick,	SMHI Sweden	11
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	3

WP objectives and priorities

Various types of satellite observations are presently being used in the DA systems. Important aspects for NWP is to enable their assimilation over all surfaces (ocean, land, sea-ice), all conditions (clear and cloudy) and to maximize their impact at every assimilation cycles.
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. Sharing impact study results within the consortium would be very valuable.
With regard to satellite instruments it is important to cooperate to use data from well-known instruments on newly launched satellites as well as to continuously refine the use of existing data from traditional instruments (i.e. improved bias correction, cloud-detection, footprint operator and handling of surface emissivities). Exploring the usage of new instruments (e.g. MTG-IRS) should also be prioritised. Considering that the planned launch dates will take place this year technical and scientific findings should be shared among the consortium.
Top priorities:
(1) Assimilation of existing observations and heritage instruments (e.g. on board NOAA-21 and FY-3E).
(2) All-sky radiances
(3) Preparation for future instruments.

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	**Clear-sky radiances:** 1) Seviri, 2) IASI and CrIS, and 3) ATOVS, ATMS, and MWHS-2: Enable the assimilation of MW and IR low-peaking channels over sea ice and land using the dynamic estimation & allocation of surface parameters (emissivity or skin temperature). Support the operational implementation of the dynamic approach. Explore new cycling strategy for VarBC coefficients. Diagnose and tune prescribed thinning distance, observation errors and their correlations. Revise, clean and homogenize the blacklisting for all satellite instruments. Update the wiki page to give instructions related to radiance assimilation.	MOAM, ChBo, MaDa, FaBa, ReEr, DaSch, OlAu, ThBu, NaFo, IsMo, MaDe, MaDi, JoCa, MaLi, SwMa, WaKh, HaDh, RaBR,	T-codes and scientific note		
DA3.2	**All-sky radiances:** 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) Explore the **All-sky approach in HARMONIE-AROME 4D-Var** 4) **IR Cloud-affected radiances**: Synergy between infra-red and microwave radiometers; 5) Test of **MSG VIS assimilation** operator within RTTOV and implementation of assimilation interface.	AdNe, FlMe, FaBa, ReEr, DaSch, OlAu, MaBo, PhCh, ElCL, AnCh, HéDu, NaFo, XxXX, ZaSa, IsMo, CrRo, BeSt, JoCa, RoSc, BeRy,	Codes and scientific note		
DA3.3	**Future satellite instruments:** Preparations for assimilation of, respectively, 1) MTG-IRS (reconstructed radiances or PCs); 2) MTG-FCI ; 3) MTG-LI; 4) IASI-NG - Metop-SG (radiances); 5) AWS-MW; 6) MWS/MWI/ICI - Metop-SG; 7) Aeolus L2 HLOS winds; 8) SCA - Metop-SG; 9) EarthCARE (cloud hydrometeors); 10) MTG-IRS (retrievals L2).	SuPa, ReEr, OlAu, MaBo, ThCa, PhCh, PaCo, MaMa, NiSa, IsMo, ErDe, GJMa, CrRo, BeSt, MaDi, JoCa, MaLi, SwMa,	Codes and scientific note		
DA3.4	**Cloud and precipitation related satellite products:** Explore the [enhanced ?] use of present and next generations satellite cloud products for initialisation and initialisation using derived radar based products.	MaLi, NiHa, BeRy,	scientific note		
DA3.5	**Scatterometer winds:** Scatterometer winds: Assist the assimilation of scatterometer data, ASCAT-B/C; 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 HY-2B/2C.	DaSch, ChPa, BeRy,	T-codes and scientific note		
DA3.6	**Atmospheric Motion Vectors (AMV):** Assist the implementation of AMV's (geo and polar wind); elaborate the blacklisting procedure.		T-codes and scientific note		

ACCORD WorkPackage description : DA4

WP number	Name of WP
DA4	Observation pre-processing, quality control, bias correction and representation error
WP main editor	**Benedikt Strajnar, Alena Trojakova, Mate Mile**

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

Participant Abbreviation	Participant	Institute	PersonMonth
ZaBe,	Zahra Belkacimi,	ONM Algeria	1
AlTr,	Alena Trojáková,	CHMI Czech	1.5
AlTr,	Alena Trojáková,	CHMI Czech/D	1.5
KaHi,	Kasper Hintz,	DMI Denmark	1
LaCh, OlGu, MaMa	Laurent Chapeau, Oliver Guillet, Marc Mandemant	Météo-France	22
HeKo,	Helga Kollathne Toth,	HungaroMet Hungary	0.5
EoWh, RóDa,	Eoin Whelan, Rónán Darcy,	MET Eireann	2
ZaSa, FaHd,	Zahra Sahlaoui, FatimaZahra Hdidou,	Maroc Meteo	4
SdH, MiKo,	Siebren de Haan, Michal Koutek,	KNMI Netherlands	2
MaMi,	Mate Mile,	MET Norway	1
MaMo, MaTh,	Maria Monteiro, Manuel Theriaga,	IPMA Portugal	0.5
MiNe,	Michal Nestiak,	SHMU Slovakia	2
JaSa,	Jana Sanchez,	AEMET Spain	1
MaRi, MaLi,	Martin Ridal, Magnus Lindskog,	SMHI Sweden	1.5

WP objectives and priorities

The main objectives are to support and study pre-processing techniques for existing and new observations in data assimilation. It involves the ODB support, the assistance and development for local observation pre-processing systems (like SAPP, OPLACE, and COPE), and the optimal use of observations with large representation error (e.g., superobbing). This WP is also devoted to support quality control related activities and bias correction, specifically for high-resolution LAM data assimilation configurations. The priority should be on the support and maintenance of existing observation pre-processing systems and on the use of those observation types (e.g., Aircraft, GNSS products, radiances, crowd-sourced observations) which are particularly important for mesoscale LAM DA.

Top priorities:
(1) Maintenance and support of existing pre-processing system
(2) Integration of new observation types and products into the pre-processing chain
(3) Development and research of advanced QC procedures and bias correction techniques
(4) Research on reduced representation error in mesoscale DA (superobbing and footprint operators)

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)
DA4.1	**Maintenance and development of ODB software and tools:** primarily involves the extraction programs from raw observations to ODB (BATOR, ObsConvert, b2o). Updates to facilitate the handling of new types of observations such as all-sky radiances and MTG-IRS data. Share knowledge on observation quality, observation errors, and blacklisting decision. Investigate possibility to produce ODB2 formatted feedback output from the screening and minimization tasks.	ZaBe, LaCh, EoWh,	T-codes and non-T-codes		
DA4.2	**Pre-processing tools before conversion to ODB (SAPP, OPLACE, ...):** 1) 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 where appropriate, considering basic quality control and a conversion to a Bator/ObsConvert-compatible format.	AlTr, HeKo, RóDa, ZaSa, FaHd, SdH, MiKo, MaMo, MaTh, MaRi,	non-T-codes		
DA4.3	**COPE:** Re-evaluate COPE with SAPP BUFR and CY46 and report on its potential, in particular address requirements for observations not currently assimilated by ECMWF : replace QC filters from the pre-processing software; implement local data formats (radar, Mode-S, BUFR, ASCII) and functionalities (HDF reader, Lambert projection, report destruction); development of common blacklisting software; evaluate functionality a new prototype pre-processing system.		T-Codes and non-T-codes		
DA4.4	**Coordination:** Communication and coordination of transversal questions (e.g. development of Bator, ObsConvert, and b2o)				
DA4.5	**Making optimal use of observations taking the error characteristics and scale differences between observation and model into account:** Evaluate scales of variability in mesoscale phenomena; investigate the effective model resolution, optimal scales for superobbing and meaningful scales for analysis updates, optimal scale for supermodding vs footprint operator; develop methodology to account for correlated observation errors, handling of gross errors, analysis and optimisation of error characteristics as well as quality control rejection limits (first-guess check and VarQC, background errors in observation space, thinning, inter-channel correlations) 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). Overall tuning of the data assimilation system.	KaHi, OlGu, SdH, MiKo, MaMi, MiNe, MaLi, JaSa,MaMa	Code and scientific note		

ACCORD WorkPackage description : DA5

WP number	Name of WP
DA5	Variational systems, e.g. with 3D-Var or 4D-Var
WP main editor	**Benedikt Strajnar, Antonin Bucanek, Valerie Vogt, Pau Escribà, Magnus Lindskog**

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

Participant Abbreviation	Participant	Institute	PersonMonth
NaAw,	Nauman Awan,	GEOSPHERE Austria	4
AnBu,	Antonín Bučánek,	CHMI Czech	1
EmAl,	Emy Alerskans,	DMI Denmark	1.5
AlLe,	Alina Lerner,	ESTEA Estonia	0.5
EtAr, LoBe, PiBr, VaVo,	Etienne Arbogast, Loïk Berre, Pierre Brousseau, Valerie Vogt,	Météo-France	12
DaLa,	David Lancz,	HungaroMet Hungary	1
IsMo, CrRo,	Isabel Monteiro, Chris Romick,	KNMI Netherlands	3
OlVi, BeMe,	Ole Vignes, Benjamin Menetrier,	MET Norway	3
MaSz,	Małgorzata Szczęch-Gajewska,	IMGW Poland	1.5
MaMo,	Maria Monteiro,	IPMA Portugal	0.25
MaDe, MaIm,	Maria Derkova, Martin Imrisek,	SHMU Slovakia	2.75
BeSt,	Benedikt Strajnar,	ARSO Slovenia	2
JaSa, CaGe, PaEs,	Jana Sanchez, Carlos Geijo, Pau Escriba,	AEMET Spain	9
MaRi, MaLi, JoFa, JeBo, SwMa,	Martin Ridal, Magnus Lindskog, José Faúndez, Jelena Bojarova, Swapan Mallick,	SMHI Sweden	12.5
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	3

WP objectives and priorities

The general goal is to refine and optimize the 3D/4D variational systems. The optimisation and refinements are currently taken place in both the MASTERODB and the OOPS environments, although the long term goal is to have all applications and facilities functional within OOPS, enabling 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 (refactored) towards an OO coding. The testing and development of OOPS components will benefit from the DAVAI framework, now ported to the ECMWF computing framework.

3D-Var systems are currently being used operationally at many institutes and several members plan for operational implementation of 4D-Var. There are some refinements and tuning of these systems to be done. Many of these are also highly relevant for future use in the ensemble-based data assimilation algorithms of DA6. The refinements and optimizations of the 3D/4D variational systems include several components. These could involve Machine Learning components focused on in DA9, and elements (B-matrix for example) from DA6, and there is a close relation to nowcasting (DA2) and cycling strategies (DA8), as well as observation usage, quality control and monitoring (DA1-DA4, DA7). Here we address:

- Develop and refine data assimilation within OOPS and make use of DAVAI framework.
- Investigate 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.
- Explore and optimise handling of B matrix derived from ensembles (DA6) and to be adopted toward nowcasting and reduced spin-up in DA2.
- Improved coupling to surface and longer long term activities towards coupled DA.

Top priority tasks:
(1) OOPS 3D-VAR assimilation with all observations that are used in MASTERODB version.
(2) 4D-Var in OOPS and refinements of 4D-Var.
(3) Overall tuning of the data assimilation system.
(4) Handling of model versus observations at different scales (link with DA4).
(5) 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)
DA5.1	**Develop and consolidate full assimilation cycles using 3D-Var OOPS binaries** in the OLIVE/VORTEX (MF) and in the other frameworks, such as HARMONIE-AROME, LACE and DASKIT. The aim is to achieve the **transition from MASTERODB to OOPS binaries** in these frameworks. This work will require collaboration on keeping consistent solutions with unit testing (see below) and exchange of results. Regular code cycle updates.	AnBu, EtAr, LoBe, PiBr, VaVo, MaMo, BeSt, CaGe,	t-codes		
DA5.2	**Consolidate the OOPS assimilation components as unit tests, including tests of OOPS objects.** Implement in DAVAÏ framework. Regular code cycle updates.	EtAr, LoBe, PiBr, VaVo, CrRo,			
DA5.3	**Participation in C++ layer** (short term: local repositories; mid-term: managed via ECMWF repository) and provide support to scientists (for getting hand-on the OOPS system). Regular code cycle updates.	EtAr, LoBe, PiBr, VaVo, BeMe,			
DA5.4	**Develop OOPS version of LAM 4D-Var** (make use of DAVAI framework at ECMWF as first step). Links with introduction of AI/ML (DA9) in various components of 4D-Var. Other components or approaches : develop large scale error constraint ; allow centred FGAT.	CrRo, PaEs, MaRi, MaLi, JoFa,			
DA5.5	**Towards operational implementation of MASTERODB 4D-Var:** Remaining optimizations of 4D-Var configuration for operational application. These include further investigation of coupling to the surface, ensure functionality with all operationally used observation types and to investigate ways to improve 4D-Var computational performance and scalability (ex. explore double vs single precision). Impact of moist physics, control of lateral boundary conditions, larger extension one setups and adoptions towards nowcasting (DA7), such as exploitation of overlapping windows, convergence at high resolution, use of high-density observations, trajectory trunctions and increment resolution. Experimentation of weakly coupled surface/upper-air DA in 4D-Var outer loops (see also coupled DA activities in DA6).	IsMo, CrRo, OlVi, JaSa, PaEs, MaLi, JoFa, JeBo, SwMa,	t-code and scientific note		

DA5.6	**Maintenance, setup, coordination and running of the state-of-art ACCORD [3D/4D-Var/BlendVar/3D] assimilation cycles:** 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, EmAl, AlLe, DaLa, MaSz, MaDe, MaIm, WaKh, HaDh, RaBR,	Scientific note		
DA5.7	**Large scale information:** Find the best solution for taking the large scales into account (Jk, LSMIX, via preconditioning, pre-mixed penalty-free Jk, BlendVar, ...). Consider increased lateral boundary condition coupling frequency.	OlVi, WaKh,	Scientific note		

ACCORD WorkPackage description : DA6

WP number	Name of WP
DA6	EnVar, EDA and variants
WP main editor	**Benedikt Strajnar, Roel Stappers, Pierre Brousseau, Benjamin Menetrier**

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,	GEOSPHERE Austria	4
AlLe,	Alina Lerner,	ESTEA Estonia	1
EtAr, LoBe, PiBr, NiGi, OlGu, NiMe, ArPu, ThMo, GaAr, VaVo,	Etienne Arbogast, Loïk Berre, Pierre Brousseau, Nicole Girardot, Oliver Guillet, Nicolas Merlet, Argan Purcell, Thibaut Montmerle, Gabriel Arnould, Valerie Vogt,	Météo-France	39.5
FaHd,	FatimaZahra Hdidou,	Maroc Meteo	2
BeMe,	Benjamin Menetrier,	MET Norway	1
BeSt,	Benedikt Strajnar,	ARSO Slovenia	2
JaSa, PaEs,	Jana Sanchez, Pau Escriba,	AEMET Spain	1
MaRi, MaLi, JeBo, SwMa,	Martin Ridal, Magnus Lindskog, Jelena Bojarova, Swapan Mallick,	SMHI Sweden	4

WP objectives and priorities

The work package is devoted to use of ensemble approaches in data assimilation, with two main R&D axes:
- Developments of ensemble data assimilation (EDA), where error contributions are simulated (through corresponding perturbations) and propagated during the assimilation cycling, to provide a sample of background perturbations.
- Development of ensemble-variational (EnVar or hybrid-EnVar, 3D and 4D versions) assimilation algorithms that use this sample to specify the B-matrix (with specific filtering methods) during the minimisation step.

Furthermore, the background perturbations to model the B-matrix within deterministic/variational algorithms (DA5) are most often provided by an ensemble approach with several possible computation methods which are to be investigated and refined. For EnVar, several implementation options can be explored (i.e. using ensemble members at coarser resolution, different LAM ensemble system or global model). Furthermore, the EnVar relaxes the specification of control vector for minimization so adding additional fields (e.g. hydrometeors and NH variables, surface fields) can be considered and is a mid-term goal.

Main priorities:
- Bring the OOPS-based EnVar to (pre) operational stage for few early members.
- Extension of control vector for minimization, including tests towards DA coupling with surface fields.
- Improvements of representation of ensemble-based B for use with deterministic variational algorithms (DA5).

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	**3DEnVar in OOPS:** update with respect to refactored IFS cycles, optimise localisation (including Scale-Dependent Localisation (SDL)), evaluate time-lagging and optional hybridation, adapt solutions to reduce spin-up effects (ex: IAU, VC, nudging), include hydrometeors	FlMe, AlLe, EtAr, LoBe, PiBr, NiMe, ThMo, GaAr, VaVo, BeSt, PaEs, JeBo,			
DA6.2	**4DEnVar in OOPS:** update with respect to refactored IFS cycles, diagnose time correlations, optimise advection and localisation, include hydrometeors. Implement and evaluate 4D-IAU.	FlMe, EtAr, LoBe, PiBr, VaVo,			
DA6.3	**EDA and its use for EnVar in OOPS:** update with respect to refactored IFS cycles, scientific improvements in EDA systems (regional and global), e.g. related to ensemble size and model perturbations.	EtAr, LoBe, PiBr, NiGi, OlGu, VaVo,			
DA6.4	**EnVar with other geophysical fields in OOPS:** surface 2DEnVar; towards coupled ocean/atmosphere/land EnVar.	EtAr, LoBe, PiBr, ArPu, VaVo,			
DA6.5	**B computation methods:** 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. Add possibility to project the background errors into observation space (BGOS).	FaHd, BeMe, MaLi, SwMa,			
DA6.6	**Other ensemble generation methods (BRAND, LETKF, EVIL):** Evaluate their impact on EnVar (possibly hybrid) and also on the balance between control variables and on spinup.	MaRi,			
DA6.8	**Particle filter:** 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				
DA6.9	**Global ensemble in LAM EnVAR:** Examine the potential of using the host model global ensemble for EnVAR. Tune relative weight between global vs lam ensemble members. Consider replacing LSMIX with a global ensemble.				

ACCORD WorkPackage description : DA7

WP number	Name of WP
DA7	Initialization methods and nowcasting
WP main editor	**Benedikt Strajnar, Florian Meier, Maria Diez**

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

Participant Abbreviation	Participant	Institute	PersonMonth
IdDe,	Idir Dehmous,	RMI Belgium	2
ClPe,	Claus Petersen,	DMI Denmark	1.5
AlLe,	Alina Lerner,	ESTEA Estonia	3
DaSch, ErGr,	David Schönach, Erik Gregow,	FMI Finland	3
GaAr,	Gabriel Arnould,	Météo-France	1
SdH,	Siebren de Haan,	KNMI Netherlands	2
MaDe,	Maria Derkova,	SHMU Slovakia	0.75
MaDi, CaGe,	Maria Diez, Carlos Geijo,	AEMET Spain	5.5
MaLi, NiHa, ToLa, SaAn, JeBo,	Magnus Lindskog, Nina Håkansson, Tomas Landelius, Sandra Andersson, Jelena Bojarova,	SMHI Sweden	5

WP objectives and priorities

Weather forecasting in the nowcasting mode is very challenging for forecasters and sufficiently accurate near real time automatic nowcast products are among most anticipated deliverables by the LAM community. The goal of this work package is to improve the existing NWP-based nowcasting suites, based on DA methodologies dealt with in DA 5-6, by focusing on methodologies and approaches that can contribute to faster and/or more balanced initialization, and spread this information with interested institutes.
Objectives are:
- Seek ways to reduce spin-up in forecasts during first 1-2 h of model integration due to imbalances caused by data assimilation procedure (e.g. IAU, DFI, nudging, field alignment, ...)
- Diagnostics of 1-2 h of model integration (like ECHKEVO and DDH) need to be further exploited. * (RUC)

Top priorities:
1. Develop and use diagnostics that allow for model spin up estimation.
2. Test the different techniques that decrease the spin up.
3. Explore initialization methods.

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)
DA7.1	Explore the implementation of **modelization of covariances with Gaussian Integrals** for DA of scalar fields (e.g. humidity, clouds, aerosols, etc..) in deterministic and ensemble contexts.	CaGe,	code and scientific notes		
DA7.2	**Tracking of structure:** Implement HybridEnVar scheme based on tracking of structures for very short forecast ranges (0-9h) based on the EPS and alpha control variables.	GaAr, JeBo,	code and scientific notes		
DA7.3	**7.3 :** 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) Nudging (LHN, back and forth technique);	CaGe,	code and scientific notes		
DA7.4	**Methods to reduce and diagnose spin up in DA:** 1) Incremental analysis update (IAU): assess in context of hourly and sub-hourly updates; 2) Application of Digital filter initialisation (DFI) in DA cycle: assess the impact on reducing the spinup effect; 3) Explore the use of DDH, ECHKEVO for estimating the observed spinup.	IdDe, DaSch, ErGr, MaDe, MaDi,	code and scientific notes		

ACCORD WorkPackage description : DA8

WP number	Name of WP
DA8	Diagnostic methods, optimization of assimilation cycling
WP main editor	**Benedikt Strajnar, Eoin Wheelan, Idir Dehmous**

Table of participants

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

Participant Abbreviation	Participant	Institute	PersonMonth
ChBo, IsLa, ZaBe,	Chahrazed Bouzerma, Issam Lagha, Zahra Belkacimi,	ONM Algeria	5
IdDe,	Idir Dehmous,	RMI Belgium	3
AnBu,	Antonín Bučánek,	CHMI Czech	1
AhMe, AlLe,	Ahto Mets, Alina Lerner,	ESTEA Estonia	2.5
ReEr, DaSch, ErGr,	Reima Eresmaa, David Schönach, Erik Gregow,	FMI Finland	3
StMa, DoRa,	Stephane Martinez, Dominique Raspaud,	Météo-France	7.5
DaLa,	David Lancz,	HungaroMet Hungary	2
EoWh,	Eoin Whelan,	MET Eireann	1
ZaSa,	Zahra Sahlaoui,	Maroc Meteo	2
IsMo,	Isabel Monteiro,	KNMI Netherlands	0.5
JaSa, CaGe, JoCa,	Jana Sanchez, Carlos Geijo, Joan Campins,	AEMET Spain	2.5
WaKh,	Wafa Khalfaoui,	INM Tunisia	1
ZeÜn, CeKı,	Zeynep Feriha Ünal, Celaleddin Kızılkaya,	MGM Türkiye	2

WP objectives and priorities

The objective of this work package is to maintain, develop and apply various diagnostics tools to assess and improve the quality of the assimilation cycle, through learning about the relative impact of observations and tuning of components of the DA system.
The central approach taken in ACCORD is application of a-posteriori diagnostics and tuning based on covariance of residuals (Desrozier's method). This methodology allows for individual tuning of observation and background errors and diagnostics of relative impact of observations (e.g. degree of freedom for signal), and the relative impact of a given observations on the short-range forecasts of the assimilation cycle. Special techniques, most total energy norm are available moist total energy norm (weight of relative observation impact on forecast) and adjoint forecast sensitivity to observation (FSOI) are focused on impact of observations in the forecast and complement the classical verification.
Further optimization can be gained by adjusting the length and position of data assimilation window with respect to nominal analysis time and by relaxing the definition of assimilation window (e.g. moving or overlapping windows, continuous data assimilation).

Priorities:

(1) Consolidate the existing DA diagnostic tools and make them available as stand-alone applications in a common git repository.

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)**
DA8.1	**Diagnostic tools:** Continue the implementation, usage 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. 7) TuneBR package to tune obs. and background error standard deviations, 8) Andersson-Järvinen to estimate the quality control rejection limits	ChBo, IsLa, ZaBe, IdDe, AhMe, AlLe, ReEr, DaSch, StMa, DoRa, EoWh, ZaSa, IsMo, JaSa, JoCa, WaKh, ZeÜn, CeKı,	non-T-codes report		
DA8.2	**Assimilation cycling strategy:** 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.***	IdDe, AnBu, ErGr, DaLa, CaGe,	Scientific note		
DA8.3	**Observing system simulation experiments:** 1) Adapt the Harmonie data assimilation system for OSSE experiments. 2) Adapt the environment of Observing System Simulation Experiments with the AROME 3D-Var to a more recent code cycle. 3) Set-up a new framework for OSSEs with a full AROME observing system (including radar data) for the preparation of future observations (ex. IRS/MTG, AWS) in AROME Var.		Scientific note		

ACCORD WorkPackage description : DA9

WP number	Name of WP
DA9	AI/ML methods for data assimilation
WP main editor	**Benedikt Strajnar, Jelena Bojarova**

Table of participants

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

Participant Abbreviation	Participant	Institute	PersonMonth
LeDC, MiVa, GeDP,	Lesley de Cruz, Michiel Vanginderachter, Geert De Paepe,	RMI Belgium	2.75
FaBa, SiCh,	Fabrizio Baordo, Simon Kamuk Christiansen,	DMI Denmark	1
SiCh,	Simon Kamuk Christiansen,	DMI Denmark/D	4
IsMo, ErDe,	Isabel Monteiro, Erik Dedding,	KNMI Netherlands	4
MiNe,	Michal Nestiak,	SHMU Slovakia	2
BeSt,	Benedikt Strajnar,	ARSO Slovenia	0.5
RoSc, ToLa, JeBo,	Ronald Scheirer, Tomas Landelius, Jelena Bojarova,	SMHI Sweden	6

WP objectives and priorities

Objective of WP9 is to explore abilities of non-linear statistical methods to achieve a more efficient use of observations to improve quality of short range numerical weather prediction forecast and nowcasts. The research will be focused on the following areas where:
1) solutions are currently not available ("the observation operator does not exist", "the useful information in attractive observations is contaminated"),
2) the quality of the existing solutions is not satisfactory ("the assumptions are too restrictive", "skills of the short range forecast are too low", "important processes are poorly resolved")
3) or the existing solutions are too costly to be affordable ("high maintenance cost", "high implementation cost", "high computational cost")

On the longer term perspective the goal is to integrate promising approaches into the convective scale numerical weather prediction system and obtain a powerful and flexible environment that could profit from advances in computer sciences and new emerging technologies. As a first step in this direction it is important to gain more experience and a better understanding of advantages and limitations of machine learning techniques. Infrastructure development and access to the training databases is the second important step on the way towards realization of the full potential of the ML techniques.

The focus of the WP9 is on the tasks where the traditional NWP experiences challenges at present and where an added value of high-resolution NWP is expected, such as
---- modeling of relationships between the model state and the observed quantities,
---- extraction of relevant information from observations,
---- emulation of expensive processes,
---- sampling of uncertainty,
---- initialisation issues,
---- improved quality of the short range forecasts.

The goal is to enhance the potential of a "traditional" numerical knowledge based weather prediction system but not to replace it with a purely statistical treatment of observations.

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)**
DA9.1	**Develop an overarching strategy of AI/ML for DA in ACCORD and coordinate development with over ACCORD Research Areas**.: 1) Prepare a scientific note to define a roadmap of AI/ML for Data Assimilation and Data Analysis 2) Assure flow of information concerning AI/ML developments between other ACCORD Research Areas, System Experts and relevant Working Groups	LeDC, JeBo,			
DA9.2	**Preprocessing and Quality Control of Emerging Observation Types** :1) Pre-processig and QC of PWS (Private Weather Stations); 2) Pre-processing and QC of Smartphone pressure data; 3) Pre-processing and QC of environmental measurements from mobile devices	MiNe,	Scientific note		
DA9.3	**Modelling of statistical observation operators** 1) forward operator for microwave passive instruments over land(CERISE); improve assimilation of the satellite microwave observations over Arctic sea ice (EUMETSAT ML Fellowship)	MiVa, FaBa, BeSt, RoSc, ToLa,	Scientific note		
DA9.4	**ML-based emulation of various components of the data assimilation chain and for enhancement of the data assimilation functionalities:** 1) accounting for systematic model errors/biases within data assimilation system; 2) enchanecements of DA system (statistical minimization, emulation of tangent-linear/adjoint) 3) sampling of uncertainty and dynamical constraints	IsMo, ErDe,	Scientific note		
DA9.5	**Data assimilation in the Latent Space:** 1) Autoencoders and Variational Autoencoders; 2) Latent Space Ensemble Filters. 3) Energy-based models. The VISSL library by Facebook (https://github.com/facebookresearch/vissl) may provide a good starting point for producing latent-space representations of forecast fields and observations.	ToLa,	Scientific note		
DA9.6	**Data driven forecasting models methods** 1) Develop and implement remote sensing based probabilistic precipitation nowcasting system (NowcastNet, ...) 2) Develop and implement limited area data driven weather forecasting models (GraphCast, ForeCastNet)	MiVa, SiCh, ToLa,	Scientific note		
DA9.7	**Infrastructure development:** 1) Building, mainteinance and access to the training databases; 2) Software support and the knowledge pool; 3) leverage the work by ECMWF on Fortran/python interface for LAM purposes				

ACCORD WorkPackage description : PH1

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

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

Participant Abbreviation	Participant	Institute	PersonMonth
IeHm,	Imad Eddine Helali Mahiddine,	ONM Algeria	4
GeSm, DvdB,	Geert Smet, Dieter Van Den Bleeken,	RMI Belgium	1.25
MaHr,	Mario Hrastinski,	DHMZ Croatia	0.75
MaHr,	Mario Hrastinski,	DHMZ Croatia/D	1.5
PtSm, RaBr, JaMa,	Petra Smolíková, Radmila Brožková, Ján Mašek,	CHMI Czech	3
LeDe,	Leif Denby,	DMI Denmark	0.25
DiRi, AdMa, SeRi, LoLu,	Didier Ricard, Adrien Marcel, Sebastien Riette, Louis Lutun,	Météo-France	23
LeRo,	Leo Rogel,	Météo-France/D	5
EmGl,	Emily Gleeson,	MET Eireann	0.5
WdR, NaTh,	Wim de Rooy, Natalie Theeuwes,	KNMI Netherlands/D	3.5
PeSm,	Peter Smerkol,	ARSO Slovenia	4
JJGA,	Juan Jesus Gonzalez Aleman,	AEMET Spain	2
MeSh, NNse, RoSc,	Metodija Shapkalijevski, Newcommer_SMHI, Ronald Scheirer,	SMHI Sweden	8.5

WP objectives and priorities

The intention is to foster thematical collaboration across ACCORD and across CSC teams, in the area of Physics parameterization. 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 video meetings, or a common workshop). On the shorter term we can learn and be inspired from each other work on the same parameterization 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 et al. approach (in mountainous areas), study the Moeng et al. 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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
PH1.1	**TKE-based mixing length (ML) formulation in TOUCANS scheme** - Testing and validating the recently found and fixed scaling issue, as well as the re-evaluated impact of buoyancy-shear formulation (BSF) in the 3D model. - Since all ML formulations within TOUCANS strongly depend on PBL height diagnostics, part of the task will be to validate the implement utilization of the Bougeault-Lacarrère upward displacements following Bašták Ďurán et al. (2022). - Adaptation (according to atmospheric conditions) and validation of the upper-air asymptotic behaviour of the BSF to represent the top PBL entrainment. - Validation of the impact of moisture in the BSF calculation by considering the motion of two parcels in different environments determined by cloud fraction, stratification and turbulence characteristics.	MaHr, RaBr, PeSm,	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.	JaMa,	doc, t-code	IAL	

PH1.3.1	**3D turbulence**: **quasi-3D turbulence** - Study and validate the performance of the implemented extension of the 1D prognostic TKE-equation turbulence scheme (Goger et al. 2019) in order to account for the 3D turbulence effects in the shear production term. After complete validation of the code in CY48, provide an impact study of this term with the TKE scheme in AROME and TKE+TTE scheme in ALARO - 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)	MaHr, PtSm, DiRi, LeRo, LoLu,	doc, t-code		
PH1.3.2	**3D turbulence: towards full 3D** - 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. - Assess the role of horizontal mixing and gradients in 3D turbulence, at the level of processes, using Méso-NH and start to compute all the horizontal gradient in AROME to use the full 3D turbulence scheme.	MaHr, DiRi, LeRo,	doc, t-code		
PH1.4	**Sensitivity of turbulence and convection in VHR runs (scale-awareness)** - 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. - strongly connected to activities in HR and MQA; investigate cooperation possibilities - for a more pragmatic adaptation (shorter term) for resolutions in the the grey zone, several ideas will be be studied and tested across the CSC: scale-aware turbulence length scale, scale aware shallow convection both combining ideas of RaHo and Pavel Kain	IeHm, SeRi, EmGl, WdR, NaTh, MeSh,	doc, papers, t-code		
PH1.5	**Meso-scale (cloud) organisation and consequent small-scale showers in HARMONIE-AROME** - continue to explore options for improving the model representation of open cell convection and the consequent too little presipitation. In this problem the influence of shallow convection, turbulent mixing, and evaporation over the sea will be investigated, but also microphysics (PH3) and usage of near-real time aerosols (PH6). - consider setting up systematic case-based investigations by using advanced observatiional platforms (e.g. cloudnet portal) for model validation and sensitivity testing; link to PH4 and MQA. - consider whether the inclusion of stochastic elements in the turbulence and convection parametrization (PH1.8) may have a beneficial impact on open cell convection and on the cloud-cover behaviour of other cloud types. -Not only for open cell convection but more in general meso-scale organisation in HARMONIE-AROME is studied within the EUREC4A (MIP) project (link to PH3.22)	LeDe, AdMa, SeRi, RoSc,			
PH1.6	**Wind-farm parameterization** Intensive testing and further developing (towards HR) the implemented wind-farm parametrization (momentum drag) in the ACCORD NWP system. In addition, merging of the cy48t2 and cy46h1 WFP codes.	GeSm, DvdB, NaTh,			
PH1.7	**Stochastic and/or learned-by-data (LBD) turbulence and convection** - explore activities towards emulation of turbulence and convection parameterization by stochastic and LBD approaches - Implement a stochastic formulation for intermittent turbulence in very stable boundary layers, along the lines suggested by Vercauteren (2022). Assess this formulation, also with MUSC.				

ACCORD WorkPackage description : PH2

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
BaAb,	Bahlouli Abdelhak,	ONM Algeria	1.5
KrNi, OlLi,	Kristian Pagh Nielsen, Ole Lindberg,	DMI Denmark	0.75
OlLi,	Ole Lindberg,	DMI Denmark/D	1
YvBo, MaMa, SoSc,	Yves Bouteloup, Marie Mazoyer, Sophia Schaefer,	Météo-France	7.5
GNPe,	Guðrún Nína Petersen,	IMO Iceland	1
EmGl,	Emily Gleeson,	MET Eireann	0.75
MeSh, KIIv,	Metodija Shapkalijevski, Karl-Ivar Ivarsson,	SMHI Sweden	1.5

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 video meetings, 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 PH2.11 below.

CLOUD - AEROSOL - RADIATION INTERACTIONS (shared with 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	About code deliverables (if any): Expected delivery (MM/YY)
PH2.1	**ACRANEB2 in single precision+sensitivity+ECRAD in ALARO** 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.	BaAb, SoSc,	t-code, new CO2+ fits	IAL	12/2023
PH2.2	**A consistent use of particle properties in microphysics-cloud-radiation schemes** 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, MaMa, SoSc,			
PH2.3	**Externalise the effective radius computation** Externalise the effective radius calculations from inside the radiation schemes; develop, recode and test within MUSC cy46. This is connected to PH6.				
PH2.4	**Derivation of a new cloud cover estimate** Explore the possibility of deriving cloud cover from the subgrid fractions and the optical depth of each water species.	SoSc,			
PH2.5	**ECRAD in HARMONIE-AROME** Consider how to introduce the ECRAD radiation scheme into HARMONIE-AROME (in collaboration with MF developments in cy48t). When implemented, assess its performance in 1- and 3D experiments compared to the default (old) IFS scheme. Make a more thorough validation of its performance.	OlLi, SoSc, GNPe, EmGl,			
PH2.6	**Consistency implementation of ACRANEB2 in HARMONIE-AROME** 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)	MeSh, KIIv,			
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 in MF's NWP.	YvBo, MaMa, SoSc, EmGl,			

PH2.10	**Machine learning (ML) to emulate/accelerate radiation** 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.				
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 specifications 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	BaAb, SoSc,			

ACCORD WorkPackage description : PH3

WP number	Name of WP
PH3	Clouds-precipitation microphysics
WP main editor	**Martina Tudor, Emily Gleeson, Eric Bazile, Meto Shapkalijevski**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
WaCh,	Walid Chikhi,	ONM Algeria	0.5
LuGe, KwVW, DeMa,	Luc Gerard, Kwinten Van Weverberg, Debasish Mahapatra,	RMI Belgium	5.5
MaTu,	Martina Tudor,	DHMZ Croatia	1
DaNe,	David Němec,	CHMI Czech	10
PaMa,	Panu Maalampi,	FMI Finland	0.5
SaAn, ErBa, YvBo, SeRi, MaJW, MaMa, BeVi, ClSt,	Salome Antoine, Eric Bazile, Yves Bouteloup, Sebastien Riette, Mareva July Wormit, Marie Mazoyer, Benoit Vie, Clément Strauss,	Météo-France	27
EmGl,	Emily Gleeson,	MET Eireann	2
WdR,	Wim de Rooy,	KNMI Netherlands/D	2
DaMa,	Daniel Martin,	AEMET Spain	3
MeSh, AbLo,	Metodija Shapkalijevski, Abhishek Lodh,	SMHI Sweden	1.5
HaDh, RaBR,	Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	2

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	**Utilization of cloudiness parameterization** Cloudiness parametrisation utilizes prognostic condensates and water vapour - Cloud scheme, shallow convection cloudiness	LuGe, DaNe, SaAn, YvBo, SeRi, MaMa, BeVi, EmGl, WdR, MeSh, AbLo,			
PH3.2	**ALARO microphysics (APLMPHYS)** - Testing and tuning on prognostic groupel in the common code - Improvement of processes and vertical geometry, study of their feedback - Analysis of aerosol introduction.	LuGe, KwVW, DeMa, MaTu,			
PH3.3	**Testing LIMA in AROME and HARMONIE-AROME** Test the behaviour of LIMA in AROME and 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).	SaAn, MaJW, BeVi, ClSt, EmGl,			
PH3.4	**Thorough comparison/evaluation of the ICE3 and LIMA schemes** - testing different configurations from LIMA in AROME and HARMONIE-AROME (e.g. on/off two moments for various hydrometeors)	WaCh, SaAn, MaJW, BeVi, ClSt, EmGl, HaDh, RaBR,			
PH3.5	**ICE-T** - Testing and validation of the implemented ICE-T in CY46 for a range of case studies - Implementing ICE-T elements in LIMA	EmGl,			
PH3.6	**Cloud-microphysics parameterization in cold climate** Investigate the representation of Arctic clouds and microphysical processes in, among others, AROME-Arctic and AROME-Svalbard. 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, and microphysics data collected during Rali-Thinice field campain.	ErBa, SeRi, DaMa,			
PH3.7	**Explore the behaviour of precipitation at the lateral boundaries (nesting problems)**	MaTu,			
PH3.8	**Sensitivity of cloud droplet number concentrations in ICE3 on clouds and precipitation** 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.	PaMa, SaAn, MaMa, EmGl, DaMa,			
PH3.9	**Parameter-sensitivity study for improving the forecast of fog** 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 Contreras et al. (2022, MDPI, Atmopshere). Include study of impact of NRT aerosol and the manner of activation of aerosols in this work.	EmGl, DaMa,			
PH3.10	**Learned-by-data (e.g., machine learning) approaches to improve micophysics parameterization** Exploration of ML-based formulation of liquid cloud optics				
PH3.11	**Parameterization of the activation of aerosols in ICE3** 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.	SaAn,MaMa			

PH3.12	**Study the influence of vertical resolution on decoupling in SBL and fog formation** Link to PH7.6				
PH3.13	**Study the impact of (LIMA) cloud microphysics in relation to fog**	BeVi,			
PH3.14	**SOFOG3D model intercomparison studies** 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.	SaAn, EmGl,			
PH3.15	**Forecast of hail in ICE3/ICE4** Further improve ICE3/ICE4 especially with respect to forecast of hail				
PH3.16	**Cold microphysics intercomparison exercice (1D MPACE case ?)**				
PH3.17	**Toward uniformisation of rain-ice versions**	SeRi,			
PH3.18	**New developments in ICE3** Use of Nc for autoconversion, pdf harmonisation)	SeRi, MaMa,			
PH3.19	**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 reduced with a new formulation of the convection time scale. Hereafter, long term verification (including EUREC4A) is necessary before operational implementation	WdR, MeSh, AbLo,			

ACCORD WorkPackage description : PH4

WP number	Name of WP
PH4	Common 1D MUSC framework for parametrization validation
WP main editor	**Meto Shapkalijevski, Eric Bazile, Martina Tudor, Emily Gleeson**

Table of participants

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

WP objectives and priorities

Maintain and regularly upgrade a “common MUSC” 1D testing environment for Arome-France, Harmonie-Arome, and ALARO, 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 developed by R. Roerhig is now available. A continuation effort shoud be done in 2023/2024 to increase the number of available "ideal" cases in order to have a diversity of meteorological situation to evaluate, compare all the parametrizations available across the CSC. Therefore a yearly training and/or working days shall be organized for the maintenance and upgrades of the common MUSC version based on a new cycle.

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)
PH4.1.1	**Establish, maintain and upgrade “common MUSC” system (EMS)**	ErBa, YvBo,			
PH4.1.2	**Integrate the DE_330 scriping environment to EMS**				
PH4.2	**Create and add (idealized) test cases**	YvBo, EmGl,			
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***	YvBo,			
PH4.5	**Set up for daily MUSC runs**				

ACCORD WorkPackage description : PH5

WP number	Name of WP
PH5	Model Output Postprocessing Parameters
WP main editor	**Claude Fischer, Emily Gleeson, Eric Bazile, Martina Tudor, Meto Shapkalijevski**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
WaCh, IeHm, BaAb,	Walid Chikhi, Imad Eddine Helali Mahiddine, Bahlouli Abdelhak,	ONM Algeria	4
BoTs, MeDi,	Boryana Tsenova, Metodi Dinev,	NIMH Bulgaria	7
MaTu,	Martina Tudor,	DHMZ Croatia	1
PaMa,	Panu Maalampi,	FMI Finland	1
SaAr, ErBa, PiCr, InEt, JMPi,	Sara Arriolabengoa, Eric Bazile, Pierre Crispel, Ingrid Etchevers, Jean-Marcel Piriou,	Météo-France	12
EmGl,	Emily Gleeson,	MET Eireann	0.5
AnSi,	Andre Simon,	SHMU Slovakia	4
MeSh,	Metodija Shapkalijevski,	SMHI Sweden	2.5

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
PH5.1	**Organisation of PH5 meetings and PH5 work flow** This work is organised and coordinated by PH5 editors in close collaboration with the MQA AL (MQA2 and MQA3 work acivity)	PaMa, JMPi, EmGl, MeSh,	minutes from these meetings		
PH5.1.1	**How to provide new output in fullpos?** Provide a clear documentation on how to introduce new (model) output in fullpos (atmosphere)		documentation or/and links to latest documentation		
PH5.1.2	**Explore tools/software to output/modify SFX.fields (e.g. regridding);** Focus on via fullpos, but investigate other posibilities		report (plan) or	IAL	
PH5.1.3	**DDH and/or fullpos** Provide a documentation on the usage of DDH for model output vs fullpos; explain pros and cons for both in specific situation	PaMa, JMPi,	documentation or/and links to latest documentation		
PH5.1.4	**GL and Fullpos output** Provide a documentation of model output done via GL for same variables/parameters but cumputed by using different methods (or units); create a list with explenation if possible	PaMa,	documentation		
PH5.1.5	**Organisation of PH5-thematic meetings** 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.	EmGl,	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, BoTs, MeDi, ErBa, InEt,	meeting in 2025; work plan proposal	IAL	tbd
PH5.3	**Convection-related (helicity, hail, lightning).** Same items 1-2-3 as in PH5.2	BaAb, BoTs, MeDi, InEt, JMPi,	meeting in 2025; work plan proposal	IAL	tbd
PH5.4	**Precipitation types and their impact on surface conditions.** Same items 1-2-3 as in PH5.2	InEt,	meeting in 2025; work plan proposal	IAL	tbd

PH5.5	**VHR turbulence-related (wind shear, gusts, EDR etc.).** Same items 1-2-3 as in PH5.2	IeHm, PiCr,	meeting in 2025; work plan proposal	IAL	tbd
PH5.6	**New products (output) not falling into any of the above categories** Improvements, tuning and validation of existing or new model output postprocessing/diagnostic fields, not falling into any of the above categories: - 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 ?)	SaAr, PiCr, AnSi,	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	**Emily Gleeson, Ján Mašek, Martina Tudor, Salomé Antoine, Meto Shapkalijevski**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MoMo, AyMe,	Mohamed Mokhtari, Ayoub Mehbali,	ONM Algeria	8
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech	2
PaMa,	Panu Maalampi,	FMI Finland	0.5
SaAn,MaMa,SoSc, BeVi,	Salomé Antoine, Marie Mazoyer, Sophia Schaefer, Benoit Vie,	Météo-France	7.5
EmGl,	Emily Gleeson,	MET Eireann	1
PiSe,	Piotr Sekuła,	IMGW Poland	4
DaMa,	Daniel Martin,	AEMET Spain	3
MeSh, KIIv,	Metodija Shapkalijevski, Karl-Ivar Ivarsson,	SMHI Sweden	1.5

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

PH6.1. IMPLEMENTING DATA FLOW OF NEAR REAL TIME (n.r.t.) AND CLIMATOLOGICAL AEROSOLS.

n.r.t. aerosol MMR fields from CAMS are extracted and accommodated in the lateral boundary files using gl software that is available for the whole consortium. From the initial / coupling files the n.r.t. MMRs are read as standard GFL fields. This enables their advection and lateral coupling, as well as easy propagation across the model code, and possibly also into the output files. n.r.t. aerosol MMRs are passed to the level of MF_PHYS, where they continue to APL_AROME and APLPAR for further processing for radiation and cloud microphysics. **The data flow of CAMS and MOCAGE n.r.t. aerosol will be checked, tested and updated as needed.**

Vertically integrated climatology of CAMS aerosol MMRs is preprocessed and accommodated in monthly climate files. These 2D fields enter model via initial file, and after reconstructing 3D aerosol MMRs (assuming idealized vertical profiles) they are used in radiation and microphysics in the same way as n.r.t. aerosol MMRs. Climatological MMRs will not be a subject to advection and lateral coupling. **The suggested data flow of climatological aerosol from climate files to the forecast model will be analysed, updated as needed and documented. Possibility to convert 2D MMRs to 3D at setup level will be considered. The possibility to replace external preprocessing of MMRs with the use of netcdf tools from ECRAD will be studied.**

Aerosol inherent optical properties (IOPs) for 11 CAMS species are preprocessed and accommodated in an ASCII file (RADAIOP). Its contents are passed to forecast model using a setup routine. **The possibility to replace external preprocessing of IOPs with the use of netcdf tools from ECRAD will be studied.**

PH6.2. AEROSOL CODE CONVERGENCE IN CLIMATE GENERATION AND FORECAST MODEL

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

PH6.3. PREPARATION OF REAL-TIME AEROSOL OPTICAL PROPERTIES FOR THE RADIATION SCHEMES

Subroutines converting CAMS aerosol MMRs and IOPs to optical properties of aerosol mixture (layer optical depth, single scattering albedo and asymmetry factor) have been created. Relative humidity, that affects optical properties of hydrophilic aerosols, is taken into account. Calculations 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	About code deliverables (if any)	
				Code contrib to repository	Expected delivery (MM/YY)
PH6.1	IMPLEMENTING DATA FLOW OF NEAR REAL TIME (n.r.t.) AND CLIMATOLOGICAL AEROSOLS.	JaMa, AnHu,	t-code		
PH6.2	AEROSOL CODE CONVERGENCE IN CLIMATE GENERATION AND FORECAST MODEL	AnHu, DaMa,	report		
PH6.3	PREPARATION OF REAL-TIME AEROSOL OPTICAL PROPERTIES FOR THE RADIATION SCHEMES	AnHu, DaMa,	t-code		
PH6.4	INTERFACING NEAR REAL TIME AEROSOLS WITH CLOUD MICROPHYSICS	BeVi, DaMa,MaMa	t-code		
PH6.5	VALIDATION AND TESTING	RaBr, JaMa, PaMa, SoSc, BeVi, EmGl, PiSe, MeSh, KlIv,	report		
PH6.6	Ensure consistency across CSCs between treatment of aerosols, clouds and radiation (related to PH6.2)	SoSc,	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, AyMe,	Documentation		

ACCORD WorkPackage description : PH7

WP number	Name of WP
PH7	On the interface between the surface and the atmosphere
WP main editor	**Meto Shapkalijevski, Patrick Samuelsson, Mario Hrastinski, Eric Bazile**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
FrDu, RaHa,	François Duchêne, Rafiq Hamdi,	RMI Belgium	2
MaHr,	Mario Hrastinski,	DHMZ Croatia	0.75
MaHr,	Mario Hrastinski,	DHMZ Croatia/D	1
JaMa,	Ján Mašek,	CHMI Czech	1
AnZo,	Andrea Zonato,	KNMI Netherlands	3
NaTh,	Natalie Theeuwes,	KNMI Netherlands/D	0.5
MeSh, PaSa, AbLo,	Metodija Shapkalijevski, Patrick Samuelsson, Abhishek Lodh,	SMHI Sweden	3
ErBa	Eric Bazile	Météo-France	0.5

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	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
PH7.1	**Coupling ALARO to SURFEX** 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.	JaMa,			
PH7.2	**Towards new urban surface-atmosphere coupling in AROME/HARMONIE** 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.	FrDu, RaHa, AnZo, NaTh,		IAL	
PH7.4	**Surface-atmosphere coupling in stable stratification** Follow up task from the stable-boundary layer side meeting at ASW in Ljubljana 2022, and physics working week in Sodankylä (focusing on 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 - Use data from observatoties (e.g., Cabauw, Norunda, Sodankylä) to set up case studies with MUSC (a link to **PH4**), SURFEX offline/online and LES (e.g. MesoNH) and thest parameterizations in SBL	MaHr, MeSh, PaSa, AbLo,			
PH7.5	**Explore alternatives to the existing grid-averaged surface flux computation** 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 and/or the turbulence	PaSa,ErBa			
PH7.6	**Risk assessment of lowest model level in surface-atmosphere coupling** 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.	MaHr, MeSh,			

PH7.8	**Surface-Radiation Coupling** (This needs to be done after ecRad has been implemented) 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 albedo, and the correct split of the atmospheric direct and diffuse shortwave irradiance components for the specific surface tiles.				

ACCORD WorkPackage description : PH8

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
YvBo, JePi,	Yves Bouteloup, Jean-Marcel Piriou,	Météo-France	1.5

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**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.	YvBo,			
PH8.2	**Consistancy in 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 (e.g. due to changes of mass of water species or atmospheric components). The idea in this task is to start evaluating the impact of these assumptions in an idealized framework: - 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 et al. 2018, and recently discussed in a paper by Peng et al. 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	**Consistent and scale-invariant parameterization of mixing processes in ALARO** 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.				

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 (e.g. 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).*	JePi,			

ACCORD WorkPackage description : SU1

WP number	Name of WP
SU1	Surface data assimilation
WP leaders	**Patrick Samuelsson, Rafiq Hamdi, Antonín Bučánek, Ekaterina Kourzeneva, Camille Birman, Stefan Schneider**

Table of participants

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

Participant Abbreviation	Participant	Institute	PersonMonth
StSc, PoSc,	Stefan Schneider, Polly Schmederer,	GEOSPHERE Austria/D	4
AnBu, AlTr,	Antonín Bučánek, Alena Trojáková,	CHMI Czech	4.5
AnBu,	Antonín Bučánek,	CHMI Czech/D	1.5
SoNi ,	Søren Borg Nielsen,	DMI Denmark	0.5
SoNi ,	Søren Borg Nielsen,	DMI Denmark/D	1
MiHa, EkKo,	Mikael Hasu, Ekaterina Kourzeneva,	FMI Finland	6
CaBi, NaFo, SoMa, ZoSa,	Camille Birman, Nadia Fourrie, Sophie Marimbordes, Zied Sassi,	Météo-France	20.5
HeKo,	Helga Kollathne Toth,	HungaroMet Hungary	5
MaMo,	Maria Monteiro,	IPMA Portugal	0.5
MiNe, ViTa,	Michal Nestiak, Viktor Tarjani,	SHMU Slovakia	2
MaLa,	Matjaž Ličar,	ARSO Slovenia	4.5
PaSa, AbLo,	Patrick Samuelsson, Abhishek Lodh,	SMHI Sweden	7
ZeÜn, CeKı,	Zeynep Feriha Ünal, Celaleddin Kızılkaya,	MGM Türkiye	4

WP objectives and priorities

The main objective is to combine different observations, and their horizontal spatialisation, with data assimilation algorithms for the vertical surface data assimilation framework.

Traditional SYNOP observations are combined or replaced with satellite based products/radiances representing e.g. 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. The tasks include data pre-processing, as a preparation for 2D spatialisation. 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.

The dominating tool for 2D horizontal spatialisation in CANARI or Pysurfex/gridpp is Optimum Interpolation (OI) but development of 2D-Var and 2D-EnVar methods are ongoing.

Algorithms of the vertical assimilation part in SODA are based on Optimum Interpolation (OI), Simplified Extended Kalman Filter (SEKF) and Ensemble Kalman Filter (EnKF). Work on observation operators, needed to assimilate satellite radiances, is included.

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

CSC details:CSC leaders, Katya, Beni, Camille, please add any relevant more specific info if you wish.

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)
SU1.1	Surface data assimilation in the horizontal	AnBu, AlTr, MiHa, EkKo, CaBi, NaFo, SoMa, ZoSa, HeKo, MaMo, MiNe, ZeÜn, CeKı,			
SU1.1.1	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.	AnBu, MaMo, ZeÜn, CeKı,			
SU1.1.3	Further develop snow analysis and assimilation based on satellite snow extent (e.g. H-SAF, Cryo) in HARMONIE-AROME, in CANARI and Pysurfex. Please state in expected outcome which assimilation method is used and where it is located (e.g. CANARI, SODA, ...).	MiHa, CaBi,			
SU1.1.4	Development of SYNOP-based snow analysis in CANARI. May include spatial analysis of snow and update of SWE. *Please specify details in expected outcome.*	AlTr, HeKo,			
SU1.1.5	Continue the development of pySurfex in HARMONIE-AROME, including TITAN and gridPP and coupling to SODA.				
SU1.1.6	2D-Var and 2D-EnVar evaluation and development in AROME-France	CaBi, SoMa,			
SU1.1.8	Examine satellite derived skin temperature using 2D OI in CANARI for AROME-France	CaBi, NaFo, ZoSa,			
SU1.1.9	Examine the use of amateur weather observations (like Netatmo) in surface assimlation in HARMONIE-AROME, using gridpp				
~~SU1.1.10~~	~~Examine and upscaling of Sentinel-3-based LAI product for daily update in AROME.~~				
SU1.1.11	Examniation and tuning of CANARI OI T2m and Rh2m analysis.	AnBu, MaMo, ZeÜn, CeKı,			
SU1.2	Vertical OI (incl. SODA) evaluation and development	AnBu, MaMo,			
SU1.2.1	Tuning of OI soil assimilation (i.e. oi_cacsts and corresponing routines).	AnBu, MaMo,			
SU1.3	SODA EKF evaluation and development	HeKo, ViTa, MaLa,			

SU1.3.1	Validation of SEKF surface assimilation for ForceRestore?? with 1 patch with SYNOP observations and operational upgrades	ViTa,			
SU1.3.2	Consider, develop and evaluate SEKF for the combination of diffusion soil, Explicit snow and MEB with 2 patches for SYNOP observations in HARMONIE-AROME				
SU1.3.3	Develop/assess EKF for sea ice, using satellite products in combination with the SICE scheme, in HARMONIE-AROME. Includes bias-aware EKF.				
SU1.3.4	Examine available satellite soil moisture products (e.g. ASCAT, SMOS) for use in SEKF surface data assimilation.	HeKo, MaLa,			
~~SU1.3.5~~	~~Use Sentinal-3-based LAI product with SEKF in AROME~~				
SU1.4	SODA EnKF evaluation and development	PaSa, AbLo,			
SU1.4.1	Consider, develop and evaluate EnKF for the combination of diffusion soil, Explicit snow and MEB with 2 patches for SYNOP observations and satellite derived products (soil moisture and other derived products) in HARMONIE-AROME.				
SU1.4.2	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.				
SU1.4.3	Develop methodology for a consistent upper air and surface perturbations in EnKF in HARMONIE-AROME. Develop methodology for a multi-patch approach.				
SU1.5	General and coding aspects (SODA developments)				
SU1.5.1	Clear interface between models (over tiles, e.g. ISBA) and DA algorithms (OI, EKF, SEKF, EnKF) in SODA and its connection to OOPS.				
SU1.6	Towards coupled data assimilation	AbLo,			
SU1.6.1	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 DA6.4.				
SU1.7	Development of surface DA tools	StSc, PoSc, SoNi ,			
SU1.7.1	Offline SURFEX runs forced by external horizontal analysis: (i) using for the soil moisture reanalysis by AROME, (ii) exploring the possibility to provide an initial state for soil variables in near-real-time in a new cycle in HARMONIE-AROME.	StSc, PoSc,			
SU1.8	Development and evaluation of observation operators				
SU1.8.1	Using of observation operators for the microwave brightness temperatures based on CMEM/HUT				
SU1.8.2	Exploring a possibility of using ML methods for observation operators. See also DA9.4.				
	Where to fit these old tasks (if they should remain since no names are there in RWP2023 nor in RWP2024):				
~~old SU1.5~~	~~Investigating the use of Land-SAF product when building the Jacobian matrix for EKF/STAEKF~~				
~~old SU1.6~~	~~Surface analysis strategy for AROME-MAROC~~				

ACCORD WorkPackage description : SU3

WP number	Name of WP
SU3	SURFEX: validation and development of existing components for NWP
WP leaders	**Patrick Samuelsson, Samuel Viana, Mario Hrastinski, Adrien Napoly, Ekaterina Kourzeneva**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
KnEi,	Kerroumi Nour El Isslam,	ONM Algeria	2
DaDe, StSc,	Daniel Deacu, Stefan Schneider,	GEOSPHERE Austria	9
StSc,	Stefan Schneider,	GEOSPHERE Austria/D	3.5
RaHa,	Rafiq Hamdi,	RMI Belgium	1
MaHr,	Mario Hrastinski,	DHMZ Croatia	1.5
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech	5
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech/D	2
OlSa, MiHa, EkKo,	Olli Saranko, Mikael Hasu, Ekaterina Kourzeneva,	FMI Finland	3
AdNa, AaBo, PaLe, MaMi, AnVe, VaMa, JeWu,	Adrien Napoly, Aaron Boone, Patrick Le Moigne, Marie Minvielle, Antoine Verrelle, Valéry Masson, Jean Wurtz,	Météo-France	14.75
NeCo,	Cdd Deode2,	Météo-France/D	10
EmGl,	Emily Gleeson,	MET Eireann	0.5
AnZo,	Andrea Zonato,	KNMI Netherlands	3
GaSt, GaSt,	Gabriel Stachura, Gabriel Stachura,	IMGW Poland	3.5
ViTa,	Viktor Tarjani,	SHMU Slovakia	3
SaVi,	Samuel Viana,	AEMET Spain	3
KIIv, PaSa,	Karl-Ivar Ivarsson, Patrick Samuelsson,	SMHI Sweden	3
ZeÜn, CeKı,	Zeynep Feriha Ünal, Celaleddin Kızılkaya,	MGM Türkiye	6

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, validate and further improve (namelist combinations and code modification) 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 climate modelling activities when appropriate.	DaDe, StSc, MiHa, EkKo, AdNa, AaBo, PaLe, MaMi, AnVe, GaSt, ViTa, KIIv, PaSa, ZeÜn, CeKı,	The evaluation of the HARMONIE-AROME setup will continue over the three domains MetCoOp, UWC-West and AEMET.		
SU3.3	Evaluate the performance of TEB on kilometric and sub-kilometric resolution in NWP and climate AROME/ALARO and HARMONIE-AROME. 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, OlSa, AdNa, AnZo, PaSa,	report, configuration		
~~SU3.4~~	~~Test DIF in the framework of (S)EKF assimilation in SURFEX, combined with AROME cycles. Validation with SYNOP stations.~~		report		
SU3.7	~~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,	Newsletters' publication, configuration		

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.	MaHr, RaBr, JaMa, GaSt,	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.	DaDe, ZeÜn, CeKı,			
SU3.12	Evaluate prognostic LAI (A-gs) for HARMONIE-AROME, AROME and ALARO				
SU3.13	Coupling to hydrological processes (offline SURFEX with TRIP)				
SU3.14	Verification of sea and lake ice conditions using SIMBA buoys.				

ACCORD WorkPackage description : SU4

WP number	Name of WP
SU4	SURFEX: development of new model components
WP leaders	**Patrick Samuelsson, Mario Hrastinski, Ekaterina Kourzeneva, Patrick Le Moigne**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
MaHr,	Mario Hrastinski,	DHMZ Croatia	0.25
ClPe, SoNi ,	Claus Petersen, Søren Borg Nielsen,	DMI Denmark	1.5
EkKo,	Ekaterina Kourzeneva,	FMI Finland	0.5
AaBo,	Aaron Boone,	Météo-France	1
BoPa,	Bolli Pálmason,	IMO Iceland	0.25
SaVi,	Samuel Viana,	AEMET Spain	2
MeSh, PaSa,	Metodija Shapkalijevski, Patrick Samuelsson,	SMHI Sweden	2.5

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

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
SU4.1	Improve representation of glaciers by use of albedo observations.	ClPe, SoNi , EkKo, BoPa, PaSa,	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.		t-code		
SU4.3	Evaluate, tune and further develop the orographic radiation (ORORAD) parameterisation.		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.	AaBo, PaSa,	t-code		
SU4.8	Evaluate of the RSL scheme over different domains and stability ranges, in connection with SU3.10 and PH7.3. Evaluate its performance also over the low vegetation tile.	MeSh,			
SU4.11	Evaluate the possibility of improving (harmonization, re-designing) of the surface diagnostics: T-RH2m, U10m.				
SU4.12	~~Implementation of 1D sea model GOTM into SURFEX and its testing within HARMONIE-AROME, to study the impact on the weather forecast and potential benefits of coupling.~~		t-code		
SU4.13	Evaluate the orographic parameterisation OROTUR				
SU4.14	Code a common tuning coefficient for ECOFG and ECOSG for tree height tuning.	PaSa,			
SU4.15	Modify diffusion soil scheme top soil layers to resamble more fluffy soil characteristics for heat and moisture and their effect on e.g. soil evaporation.	PaSa,			

Wish-list:

	Develop a physically based glacier model for SURFEX based on the Explicit Snow Scheme.		t-code		
	New surface layer turbulence a la Niels Woetmann Nielsen.				

ACCORD WorkPackage description : SU5

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
KnEi,	Kerroumi Nour El Isslam,	ONM Algeria	2
SaOs,	Sandro Oswald,	GEOSPHERE Austria	2
SaOs,	Sandro Oswald,	GEOSPHERE Austria/D	2
RaHa,	Rafiq Hamdi,	RMI Belgium	0.5
MaHr,	Mario Hrastinski,	DHMZ Croatia	0.25
OlSa,	Olli Saranko,	FMI Finland	1
PaMa, OlSa, EkKo,	Panu Maalampi, Olli Saranko, Ekaterina Kourzeneva,	FMI Finland/D	11
DiTz,	Diane Tzanos,	Météo-France	6
BoPa,	Bolli Pálmason,	IMO Iceland	1.5
BoPa,	Bolli Pálmason,	IMO Iceland/D	1
FiSo, MaLo,	Filippe Sousa, Manuel João Lopes,	IPMA Portugal	0.5
PaSa,	Patrick Samuelsson,	SMHI Sweden	0.5

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

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): 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, EkKo,	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. Potentially evluate new data sets		report, code		
SU5.4	Lake database (GLDB) Participate in GLDB developments and studying the impact.		database, code, reports		
SU5.5	ECOCLIMAP SG activities. Examining and participate in developments. Impact studies are also described in MQA3.	OlSa, DiTz, MaLo, PaSa,	report		
SU5.6	Development of the fine (hectometric) scale Cover map for Europe using ML approach. Link with DEODE.	SaOs, PaMa, OlSa, FiSo,			
SU5.7	Tools (with documentation) for handling of physiography data. Work to increase the efficiency of PGD: optimization and clipping. Link with DEODE.	SaOs, BoPa,			
SU5.8	Use Open street map as alternative land cover for SURFEX. Should be coordinated with SU5.6				

ACCORD WorkPackage description : SU6

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth	
CNRM	Cindy Lebeaupin-Brossier, Sylvie Malardel, Marie-Noëlle Bouin, Fleur Nicolay, Soline Bielli, Jonathan Bouvier	Météo-France		?
EkKo,	Ekaterina Kourzeneva,	FMI Finland	0.5	
ClSo, MnBo, FlNi, CiLe	Clément Soufflet, Marie-Noelle BOUIN, Fleur NICOLAY, Cindy LEBEAUPIN-BROSSIER	Météo-France	14.5	
KrGu,	Kristinn Guðnason,	IMO Iceland	2	
HdV,	Hans de Vries,	KNMI Netherlands	4	

WP objectives and priorities

The main objective of this work-package is to coordinate development with respect to coupling to wave, ocean and sea-ice 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 analysis or other models and constant during forecast. Some AROME configurations at Météo-France for over-seas domains include an explicit representation of the vertical ocean mixing during the forecast. 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 3D ocean (eventually including sea-ice) / wave models.

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.

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).

For AROME, the coupling with ocean and waves is developed in the frame of the AROBASE Météo-France/CNRM project that aims to assemble a kilometre-scale limited-area multi-coupled modelling system of the physico-chemical atmosphere, the ocean (including sea-ice and marine biogeochemistry), waves and land surfaces (soil, vegetation, cities, snow, lakes and rivers). AROBASE has important development criteria that are i) the transportable nature of the regional multi-coupled model and ii) the modular aspect to couple the relevant environmental components according to different needs (research, operational forecast, regional climate study). The AROBASE platform combines the AROME atmospheric model with NEMO and MFWAM for ocean and waves respectively. The modularity is ensured by the SURFEX/OASIS interface (Voldoire et al. 2017) that permits to interconnect other component models, such as the WAVEWATCH3 wave model as it was used in Sauvage et al. (2021) and is also tested at LACY.
The main development tasks for next years are:

- the validation of the MFWAM (WW3) coupling with atmosphere and ocean, including new sea surface fluxes parametrization adapted to waves (Bouin et al. 2024) and specifically for tropical cyclones;
- the maintenance of the coupling interface in new code versions of SURFEX and AROME and the insertion of AROBASE in the dedicated environment tools for operational forecast;

The evaluation of coupling impacts for numerical prediction taking into account the operational constraints will be done by comparison of benefits (case studies, skill scores, new sequence for production chain) to costs (numerical costs and running time, addition of pre-/post-treatments, transfers to (new) users, maintenance).

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	About code deliverables (if any): Expected delivery (MM/YY)
SU6.1	Set-up of AROBASE (AROME-based) coupled system	ClSo, MnBo, FlNi, CiLe			
SU6.1.1	Maintenance of the AROME-SURFEX-OASIS interface for O-A-W coupling in operational context		t-code		
SU6.1.2	Validation of wave coupling including adapted sea surface fluxes parametrization	ClSo,			
SU6.1.3	Improvement and validation of the coupled system for TCs cases	ClSo,			
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	KrGu, HdV,			
SU6.3.1	Wave model -WW3. With operational NWP application in mind.		t-code		
SU6.3.2	Coupling of HCLIM (climatological version of HARMONIE-AROME) with NEMO				
SU6.4	Further improve AROME/CMO coupling for tropical cyclone prediction				

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
MaDa, AlKa,	Markus Dabernig, Alexander Kann,	GEOSPHERE Austria	2.5
ToJU,	Toni Jurlina,	GEOSPHERE Austria/D	1.5
GeSm,	Geert Smet,	RMI Belgium	0.5
IrOd, IvVu,	Iris Odak, Ivan Vujec,	DHMZ Croatia	2
ClBr, LePf, MaTa, LaRa, MiZa, XxYy,	Clement Brochet, Leo Pfitzner, Maxime Taillardat, Laure Raynaud, Michael Zamo, Remplaçant De M. Zamo,	Météo-France	24
ViSa, AnBo, MaLa,	Victor Sanchez, Angélique Bonamy, Maxence Lame,	Météo-France/D	22.5
KaJR,	Katalin Javorne Radnoczi,	HungaroMet Hungary	4
BaAl,	Badreddine Alaoui,	Maroc Meteo	3
MaSc, BaFr,	Maurice Schmeits, Bastien François,	KNMI Netherlands	0.5

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

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): 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.	MaSc, BaFr,	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, including temperature.	LePf, MaTa, MiZa, XxYy, KaJR,			
E6.4	Generation and downscaling of ensemble members by deep learning approaches (GAN, auto-encoders or diffusion-based models): (1) evaluation for extending AROME-EPS members, for pdf dressing and for calibration; (2) For use in hydrological modeling where dependencies in space and time are important.	MaDa, AlKa, ToJU, ClBr, ViSa, AnBo, LaRa, MaLa,	Trained neural networks, scientific publications		
E6.5	Continue work on machine learning post-processing method to improve the point or gridded forecast of high-resolution meteorological output fields. Investigate the applicability of ML methods for other forecast fields.	GeSm, IrOd, IvVu, LePf, MaTa, MiZa, XxYy, BaAl,	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, RuMe, DvdB,	Geert Smet, Joris Van den Bergh, Hossein Tabari, Ruoke Meng, Dieter Van Den Bleeken,	RMI Belgium	3.5
HeFe, JeSø,	Henrik Feddersen, Jens Havskov Sørensen,	DMI Denmark	2
ArMo, MaPl, FlRo, AlAA, LaRa, SuAn, FrBt, GaCo, HuMa	Arnaud Mounier, Matthieu Plu, Flore Roubelat, Alexandre Albert-Aguilar, Laure Raynaud, Suzanne Angeli, Francois Bouttier, Gabriel Colas, Hugo Marchal	Météo-France	51.75
KaJR, PaSe, DaTa,	Katalin Javorne Radnoczi, Panna Sepsi, David Tajti,	HungaroMet Hungary	3
MBell,	Martin Bellus,	SHMU Slovakia	1.5

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

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)
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.	ArMo, MaPl, LaRa, SuAn, KaJR, PaSe, DaTa, MBell,	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). Setup operational production (Contr. MF)	HeFe, AlAA, LaRa,	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 (contr. RMI). Clustering methods to extract user-relevant scenarii from ensembles (Contr. MF).	GeSm, JvdB, HoTa, RuMe, DvdB, ArMo, FlRo, LaRa,	report, scientific publications		
~~E7.4~~					
E7.5	Ensemble post-processing for severe weather prediction (heavy precipitation, convective gusts, tornadoes, road icing, coastal wave-induced hazards)	FrBt, HuMa	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, GaCo	scientific publication(s) /report(s)		
E7.8	Use of AROME and Harmonie-AROME ensemble forecasts for emergency dispersion modelling (nuclear or chemical)	JeSø,	scientific publications/reports		
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)				
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. Use aircraft observations to update ensemble forecasts in real time (contr. MF)	MaPl, LaRa, SuAn,	scientific publication(s) /report(s)		
E7.11	Creation of new probabilistic products and visualizations to meet the different users requirements, new fullpos fields (and grib coding) and minimize the required data traffic	KaJR, PaSe, DaTa, 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,	GEOSPHERE Austria	8
OlNu, GrRo, Selv, LaRa,	Olivier Nuissier, Gregory Roux, Selvaraj, Laure Raynaud,	Météo-France	24
KaJR,	Katalin Javorne Radnoczi,	HungaroMet Hungary	2
BaAl, MoJi,	Badreddine Alaoui, Mohamed Jidane,	Maroc Meteo	3
OlVi,	Ole Vignes,	MET Norway	1
JaRo,	Jadwiga Róg,	IMGW Poland	2
MaDe, MBell,	Maria Derkova, Martin Bellus,	SHMU Slovakia	7
MaLa, JuCe,	Matjaž Ličar, Jure Cedilnik,	ARSO Slovenia	2.5
UlAn,	Ulf Andrae,	SMHI Sweden	0.5

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	About code deliverables (if any): 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, Selv, LaRa, JaRo, 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. Pre-operational C-LAEF system at 1km. Extension of domain.	FlWe, ClWa, MaLa, JuCe,	non-t-code		
E8.4	Optimization and tuning of convection-permitting ensemble system on HPC at HungaroMet	KaJR,	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.	MaFr, OlVi, UlAn,	non-t-code		
E8.8	Maintenance and regular upgrades of the operational A-LAEF system running at ECMWF HPCF	MBell,	non-t-code		
E8.10	Development of an ALARO-based convection-permitting EPS coupled to the regional ensemble A-LAEF, running at SHMU HPC	JaRo, MBell,	non-t-code		
E8.11	Development of an hectometric (750m resolution) version of Arome-France EPS, first as a research demonstrator.	Selv, LaRa,			
~~E8.12~~					

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,	GEOSPHERE Austria	1
GeSm, MiVa,	Geert Smet, Michiel Vanginderachter,	RMI Belgium	1.25
EnKe,	Endi Keresturi,	DHMZ Croatia	1.25
HeFe, MaFr,	Henrik Feddersen, Martin Lyskjær Frølund,	DMI Denmark	2
MaFr,	Martin Lyskjær Frølund,	DMI Denmark/D	2
JaKa, PiOl, KaHa,	Janne Kauhanen, Pirkka Ollinaho, Karoliina Hämäläinen,	FMI Finland	6.5
PiOl,	Pirkka Ollinaho,	FMI Finland/D	1.5
LaDe, OlNu, GrRo,	Laurent Descamps, Olivier Nuissier, Gregory Roux,	Météo-France	8
NeCoHu,	New Comer Hu,	HungaroMet Hungary	2
XiZh,	Xiaohui Zhao,	IMO Iceland	2
JaFa,	James Fannon,	MET Eireann	1
JaFa,	James Fannon,	MET Eireann/D	3
BaAl, MoJi,	Badreddine Alaoui, Mohamed Jidane,	Maroc Meteo	5
SvdV, CaSe,	Sibbo van der Veen, Camiel Severijns,	KNMI Netherlands	3
InFr,	Inger-Lise Frogner,	MET Norway	6
MBell,	Martin Bellus,	SHMU Slovakia	1
UlAn,	Ulf Andrae,	SMHI Sweden	0.75

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

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
E9.1	Model perturbations for AROME-EPS versions: assess parameter perturbations, SPPT, SPP.	LaDe, OlNu, GrRo, NeCoHu, BaAl, MoJi,	Scientific publications, reports		
E9.3	Further comparison of ALARO and AROME members in RMI-EPS will be done.	GeSm,	Non-t-code		
E9.4	SPP (Stochastically perturbed parameterizations) will be further developed and tested, by making more parameters ready for operations and by adding more parameters to the scheme.	JaKa, PiOl, KaHa, XiZh, SvdV, OlVi, JaFa, InFr	Namelist tunings. New code for new parameters and correlations.	IAL	12/25
E9.5	Improve stochastic parameter perturbations (SPP) in C-LAEF, expansion to dynamics & SURFEX.	ClWa,	t-code	IAL	12/24
E9.6	Work on a flow dependent stochastic perturbation scheme (add perturbations where they are most effective). Investigate the possibility of using AI for this perturbation scheme.	EnKe, CaSe, UlAn,	t-code	IAL	12/25
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, MaFr, XiZh, JaFa	Report		12/25

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
FlWe,	Florian Weidle,	GEOSPHERE Austria	1
GrRo,	Gregory Roux,	Météo-France	1
BeMe,	Benjamin Menetrier,	MET Norway	2
MBell,	Martin Bellus,	SHMU Slovakia	1

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,			
E10.3	Explore the use of EnVar and Hybrid EnVar to create initial conditions for ensemble members. Test what perturbations are suitable and perform the best.	FlWe, BeMe,			12/25
~~E10.5~~	~~Test different cycling strategies and retune initial perturbations.~~		~~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.~~		~~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
HeFe,	Henrik Feddersen,	DMI Denmark	1
AnSi , HaMc,	Andrew Singleton, Harold McInnes,	MET Norway	8.5
UlAn,	Ulf Andrae,	SMHI Sweden	0.75

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).~~				
E11.2	Continue work on extending SPP to surface parameters.	AnSi, HaMc	First implementation	IAL	12/25
E11.6	Impact of surface perturbations, in particular soil moisture perturbations, on prediction of high impact summer weather, such as thunderstorms and heat waves.	HeFe,	Scientific publications, reports		
~~E11.7~~	~~Implementation of surface perturbations into convection-permitting ensemble system at HungaroMet. SPP in Surfex.~~		Scientific publications, reports		
E11.8	Test the implications of the multi-layer suface shemes on existing surface perturbations (PertSurf) and surface SPP, and adapt to the new surface scheme if necessary	UlAn,			

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
PiCe, LaDe, CaLa,	Pierrick Cebron, Laurent Descamps, Carole Labadie,	Météo-France	9

WP objectives and priorities

Optimize use of lateral boundaries from global model

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)**
E12.3	Improvements of the global ARPEGE-EPS that improve AROME-EPS through the lateral boundary coupling.	PiCe, LaDe, CaLa,			

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
PoSc,	Polly Schmederer,	GEOSPHERE Austria	1
AlDe,	Alex Deckmyn,	RMI Belgium	1
CaPe, HaSc,	Carlos Peralta, Hauke Schulz,	DMI Denmark	1.75
AhMe,	Ahto Mets,	ESTEA Estonia	1
DaTa,	David Tajti,	HungaroMet Hungary	1
JaFa,	James Fannon,	MET Eireann	0.5
AnSi ,	Andrew Singleton,	MET Norway	2.5
MiNe, MaPe,	Michal Nestiak, Martin Petras,	SHMU Slovakia	2
JJGA,	Juan Jesus Gonzalez Aleman,	AEMET Spain	1
DaYa,	Daniel Yazgi,	SMHI Sweden/D	2

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 (https://github.com/harphub) 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/. In addition to harp itself, software for carying out verification controlled by configuration files is maintained in the repository https://github.com/harphub/oper-harp-verif (MQA1.4). Other user applications, such as tools for data access and pre processing may be contributed in the repository harpUserScripts.

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 2025 and beyond. Documentation and support for users is of high priority, and to this end tutorials and manuals are maintained on github and an online harp book will be compiled. I addition 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** Examples of applying scale selective verification and ingesting new data types (in addition to station data) need to be added to the harp_tutorial. The harp slack channels will continue to be the principal way for harp-users to get peer-support. The harp community will continue to meet about once in a quarter to exchange news and make plans for new developments. 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. Enhance and build new pkgdown websites for each of the harp packages to include all function documentation and package vignettes describing common use cases. Build a website to share code extracts for specific uses of harp functions	PoSc,	documentation, tutorials, peer support		
MQA1.2	**Harp code development** Improve Shiny apps to be more user friendly and to show more diagnostics. Bring together the work flows for point-based and spatial verification. Continue exploring the possibilities of combining code in R and other languages. Furthermore, investigate the possibility of the fly computation of scores, automatic report generation and interactive plots using Shiny and Quarto.	PoSc, AlDe, AhMe, DaYa,	code updates	harp	continuous
MQA1.3	**Harp enhancements** Implementation new capabilites (data ingest, metrics, display) into harp, including measures developed in WP MQA2. Metrics supporting scale-selective verification of probabilistic forecasts should receive a high priority. Interfaces are therefore needed to data supporting scale-selective verification, such as gridded high-resolution analyses, precipitation estimates from IMERG and OPERA, OPERA reflectivity data, and data from satellite instuments used as radiances or as retrieved properties of clouds and hydro meteors. Interfacing harp with other programming languages (such as Python) should be explored.	AlDe, CaPe, HaSc, DaTa, MaPe,	code updates	harp	
MQA1.4	**Harp applications** (*Specific activites to be updated*) Ensemble verification and scale-selective metrics, including advanced display using the Panelification tool developed by Geosphere.Austria should be incorporated in the accord-verif-scripts repository on harphub, utilizing as far as possible exisiting software developed by local teams as well as under DestinE E-DT. Users of harp are encouraged to share utility software for accessing data and preprocessing and employing harp in various ways in the common repository harpUserScripts on harphub. Examples of functions performed by harpUserScripts include preselecting domains or converting data formats, such as storing forecasts in SQLite files, computing and displaying descriptive or comparative statistics, etc.	MiNe,	Enhancements to oper-harp-verif and harpuserScripts	harp	

ACCORD WorkPackage description : MQA2

WP number	Name of WP
MQA2	Development of new methods for verification and validation
WP main editor	**Carl Fortelius, Juan-Jesús González Alemán, Joël Stein**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PhSc,	Phillip Scheffknecht,	GEOSPHERE Austria/D	2
GeSm, ThVe, JvdB, RuMe, DvdB,	Geert Smet, Thomas Vergauwen, Joris Van den Bergh, Ruoke Meng, Dieter Van Den Bleeken,	RMI Belgium	2
CaPe, HeFe, HaSc,	Carlos Peralta, Henrik Feddersen, Hauke Schulz,	DMI Denmark	2
PaSe, DaTa,	Panna Sepsi, David Tajti,	HungaroMet Hungary	6
EmGl, JaFa,	Emily Gleeson, James Fannon,	MET Eireann	3.75
JJGA,	Juan Jesus Gonzalez Aleman,	AEMET Spain	2
AkJo,	Åke Johansson,	SMHI Sweden	3

WP objectives and priorities

This work package concerns the development and trial of new methods for verifying forecasts and validating forecasting systems. Imroved methods ansd metrics that are able to quantify the forecast quality with respect tom high impach weather (MQA2.7), and methods that support a process oriented verification - verifying not only the numerical values of individual forecast parameters, but also the underlying physical processes (MQA2.4 and MQA2.5), are thematic areas that should receive special attention.

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 and high-resolution observations or analyses are needed. Especially in data sparse areas, forecasts may be verified against analyses of forecasting systems such as the ECMWF highres. New neighbourhood-based methods are applied to ensemble forecasts to introduce spatial tolerance in the computation of probabilistic scores in task MQA2.3.

MQA2.1 focuses on using remote sensing observations (satellite data, radar networks, lightning detection, et c.) to evaluate the development and fine-scale 3D-structure of foreasts with respect to clouds, precipitation and convection. Each of these data sources has its limitations, and their use may involve application (or development) of post-processing algorithms (observation operators) providing the model-counterpart of each observation type in use (see wp PH5).

Much more observations are used for data-assimilation than for verification, and the methods used to compare observations to model counterparts can be extended to cover all forecast ranges. Synergies with data assimilation are exploited under task MQA2.6. Forecasting extreme events is a principal application of LAM NWP. Challenges of verifying high impact weather, often related to extreme, and therefore, rare, events are dealt with in task MQA2.7. Improved methods to quantify spread versus skill are developed in MQA2.9. The verification of forecasts over urban areas will call for an increasing attention to data sources and verifiaction methods serving the built-up environment.

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 new verification method(s), aiming to provide a deeper insight into the ability of the model/EPS system to represent (a) the 3-D state of the atmosphere and (b) the processes determining cloud, convection and precipitation formation. Due to the fast and deep inception of AI, it is recommended to focus and explore AI-based verification methods. Also recommended lagrangian-based (object-aimed) verification methods for the arrival of very-high resolution simulations and also account for timing errors.		code		
MQA2.2	Verify wind forecasts at levels relevant for wind farming	GeSm, JvdB, RuMe, DvdB, HaSc,	Method and report		
MQA2.3	New neigborhood-based methods are applied to the verification of ensemble forecasts to allow the comparison of deterministic and ensemble forecasts.		Code, validation study in a peer-reviewed publication		
MQA2.4	Gain experience with the use of observations from dedicated networks like Cloudnet, CLARA and Surfnet and from satellites such as Calypso and Earthcare, and assess the possibilities they offer for being used in process-oriented validation and verification.	PaSe, DaTa,	Reports		
MQA2.5	Start building up stepwise a process-oriented verification system which can be run from harp, by bringing in, and assessing for several processes, suitable combinations of process-relevant observations from routinely available sources, model parameters and metrics.		Plans		
MQA2.6	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.		Method and report		
MQA2.7	Develop verification methods/tools tailored for high impact weather, e.g. informing on intensity, spatial location/scale, temporary evolution of event, exceedance probabilities for nationally adjustable levels. Lagrangian-based methods are particularly suitable for evaluation of extreme convective events.	PhSc, ThVe, CaPe, HeFe,	Method and report		
MQA2.8	Gather a set of test cases for several important types of severe events and covering a range of different regions, together with the ancillary data to run them, with which the verification/tools mentioned in MQA2.7 can be evaluated.		Collection of cases		

MQA2.9	A more physically based criterion for quantifying skill versus spread in an EPS has been developed. It is based on using only statistically equal and bias-free ensemble members and accounting for them individually using U-statistics instead of the aggregate quantity ensemble mean. Furthermore, the verification is done against the perceived "truth" using the BLUE (Best Linear Unbiased Estimate) concept instead of against observations and/or analyses. In order for the new verification to be readily available for use within the ACCORD consortium it will now be incorporated into harp. In order to apply the new method on sub-daily timescales the effect of the daily cycle of variability on the verification results has to be properly accounted for.		(i) The code and software that has been developed to calculate the verification statistics will be incorporated into a package that feeds the new verification data into harp. (ii) Software will be developed within harp to enable visualization within harp of the new scores. (iii) Enhancement to the original code will be made which enable the verification results on sub-daily scales to be unaffected by undesirable fluctuations due to the daily cycle of variability.		2025

ACCORD WorkPackage description : MQA3

WP number	Name of WP
MQA3	Model validation and error attribution
WP main editor	**Carl Fortelius, Christoph Wittman, Andre Simon, Metodija Shapkalijevski**

Table of participants (for Météo-France, the total PersonMonth is the weighted sum of the individual contributions)			
Participant Abbreviation	**Participant**	**Institute**	**PersonMonth**
ZaBe, WaCh,	Zahra Belkacimi, Walid Chikhi,	ONM Algeria	1.5
ChWi, ClWa, NaAw, DaDe,	Christoph Wittmann, Clemens Wastl, Nauman Awan, Daniel Deacu,	GEOSPHERE Austria	4.5
PhSc,	Phillip Scheffknecht,	GEOSPHERE Austria	1
BoTs, MeDi,	Boryana Tsenova, Metodi Dinev,	NIMH Bulgaria	4
MaHr, EnKe, IrOd, IvVu,	Mario Hrastinski, Endi Keresturi, Iris Odak, Ivan Vujec,	DHMZ Croatia	4
CaFo,	Carl Fortelius,	FMI Finland	3
HeBe, MiGl, YvBo, InEt, PaLa, VeMa, JoSt, FaSt, MaMa, AdNa, DaPr, CaCh,	Herve Benichou, Michael Glinton, Yves Bouteloup, Ingrid Etchevers, Pascal Lamboley, Veronique Mathiot, Joel Stein, Fabien Stoop, Marie Mazoyer, Adrien Napoly, Danaé Preaux, Camille Choma Bex,	Météo-France	57
WdR,	Wim de Rooy,	KNMI Netherlands	0.75
MaKo,	Marcin Kolonko,	IMGW Poland	1
SiTa, AlCr, RaPo,	Simona Tascu, Alexandra Craciun, Raluca Pomaga,	Meteo Romania	9
MaPe, AnSi,	Martin Petras, Andre Simon,	SHMU Slovakia	2.5
JaCa, JJGA,	Javier Calvo, Juan Jesus Gonzalez Aleman,	AEMET Spain	2
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	9
ZeÜn, CeKı,	Zeynep Feriha Ünal, Celaleddin Kızılkaya,	MGM Türkiye	4

WP objectives

The goal of this work package is to ensure that new developments of the common forecasting systems are properly validated and that the causes of systematic and/or significant forecast errors can be found and dealt with.

The WP is organised as three tasks:
1) performing meteorological assessments of new model components and new releases of ACCORD forecasting systems (release candidates, e-suites) (MQA3.1)
2) performing diagnostic studies and forecast experiments aimed at attributing causes to forecast error (MQA3.2)
3) working out good practices for meteorological testing (MQA3.3 - 3.5)

Technical testing of updates is described in WPs COM2.1 (at integration time in a new code release) and COM3.1 (local installation). In addition, new or modified components need to be meteorologically evaluated before introduction in new releases of the forecasting systems (unit testing). It is important to make sure that new components function and interact with other components of the system in the intended way under all circumstances. Innovations improving the model in some processes or circumstances of particular interest must not cause significant degradation in others. This kind of component validation often involves comparing outcome from single-column (MUSC) or full model integrations to data from field campaigns or research networks or Large Eddy Simulations (LES), and should precede the evaluation of release candidates and e-suites in extensive integrations.

After technical testing and unit testing, release candidates and e-suites need to undergo a thorough meteorological evaluation (integration testing) covering all relevant seasons, weather types, climatic regimes, and geographic regions. In addition to point wise verification, 2-D and 3-D structures need to be assessed, especially in relation to clouds and microphysical processes. The sparse networks of surface weather stations and radio soundings should be complemented wth sources of high-quality spatially dense in-situ data such as air craft, and with retrievals of cloud properties and precipitation from earth observation systems. Differences in results of new and pre-existing model verwsions should be examined and understood. In order to reveal compensating errors, highly aggregated quality measures such as mean bias or rmse summarised over large domains and long periopds should be broken up into components representative of different geographical regions, times of day, weather type, etc. Quantitative summary scores should be complemented by a qualitative, process-oriented analysis, focussing on the distribution and relationships between variables in space and time. Mean diurnal cycles, initiation and life cycles of convective systems, the partitioning of hydrometeors into different types, or the relative magnitude of surface energy budget components are examples of topics for such analysis.

The causes of systematic or otherwise significant errors in operational forecasts need to be understood and related to specific features of the model or post procesing, or in the observation usage, whenever possible. To this end, diagnostic verification of the same kind that is used for evaluating new cycles should be applied to operational forecasts whenever needed. Input from duty forecasters and other users should be allowed to trigger investigations into cases of interest.

The feasibility of implementing common practices for meteorological testing, based on comparing model outcome to observations from supersites, research networks, and other sources, as well as Large Eddy Simulations (LES) needs to be explored. The starting point should be a virtual and/or actual collection of tools and data that have already been found by developers to be useful for validation and process-oriented verification. Recommendations are needed for the proper validation of components, as well as software for their implementation. The aim is that, whenever a component is modified or a new cycle arrives, such tests can be done either individually or as a group, to assess and document the impact of such a change. Priority should be given to defining a set of meteorological validation test cases (1D as well as 3D) for the atmospheric and surface model components, respectively. Documentation of the cases should be provided, e.g., on the ACCORD wiki. Common data structures and formats ensuring the presence of adequate meta data need to be identified and taken on board. The data conventions used in Cloudnet and The Merged Observatory Datra Files (MODFs) and Merged Model Data Files (MMDFs) used in the frame of the YOPP might be good candidates for point wise data. A prototype common environment capable of providing data and software to carry out one or a few selected validation excercises should be created on a common platform.

Validation is an essential part of development, and therefore it is logical to record the working time spent on validating specific developments of parameterisations or other components under the area where the development belongs (e.g. PH, SU). By contrast, activities related to evaluating entire forecasting systems, attributing errors, or developing the common practices for validation should be recorded under MQA3.

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	**Evaluation of updates and new cycles:** Planning, execution, analysis, and documenting of meteorological tests for updated model components and versions of CSCs and operational implementations.	ZaBe, WaCh, ChWi, PhSc, ClWa, NaAw, BoTs, MeDi, MaHr, EnKe, IrOd, IvVu, CaFo, HeBe, MiGl, YvBo, PaLa, VeMa, MaMa, AdNa, CaCh, WdR, MaKo, SiTa, AlCr, RaPo, MaPe, JaCa, WaKh, HaDh, RaBR, ZeÜn, CeKı,	Evaluation reports		

MQA3.2	**Error attribution** Activities of this task include planning, conducting, and documentation of investigations into the causes and mechanisms behind persistent or otherwise significant forecast errors. In particular, analysis and further investigation of issues reported by users fall into this category. Analysis of verification data, process-oriented verification covering selected periods and cases of interest, identifying and collecting relevant research data (e.g. LES), experimentation in full 3-D or in single column mode, making use of diagnostic utilities such as DDH and various research data, organization and participation in thematic meetings and other forms of collaboration, e.g within ad hoc expert teams are all examples of such activities.	DaDe, CaFo, MiGl, YvBo, InEt, LeLa, YaLe, VeLi, JoSt, FaSt, MaMa, DaPr, WdR, AnSi, JaCa,	Documented investigations, recommendations for alleviation of issues		
MQA3.3	Compile an inventory of data sets and diagnostic software for process oriented verification and validation, including documentation.	CaFo,	Inventory		
MQA3.4	Work out common recommendations for validation of components and entire models.	CaFo, WdR,	Recommendations		
MQA3.5	Identify useful common data standards enabling comparison of model output with data from research networks (e.g. Cloudnet, YOPP, SURFnet, CLARA). Prepare software for extracting model output compliant with such standards.	CaFo,	Documents		

ACCORD WorkPackage description : MQA4

86.5

WP number	Name of WP
MQA4	Verification of operational forecasts and user interaction
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
ZaBe, NaAb, ZaBe,	Zahra Belkacimi, Nadia Aber, Zahra Belkacimi,	ONM Algeria	4
ChWi, PhSc, AlRa,	Christoph Wittmann, Phillip Scheffknecht, Alexander Radlherr,	GEOSPHERE Austria	2
AlDe, IdDe, GeSm, JvdB, MiVa, RuMe,	Alex Deckmyn, Idir Dehmous, Geert Smet, Joris Van den Bergh, Michiel Vanginderachter, Ruoke Meng,	RMI Belgium	2.75
KrNo,	Kristina Klemenčić Novinc ,	DHMZ Croatia	0.25
AhMe, KeSi,	Ahto Mets, Kertu Sild,	ESTEA Estonia	2
EeSa,	Eerik Saarikalle,	FMI Finland	3
InEt, LeLa, YaLe, VeLi, DaPr, FaDu,	Ingrid Etchevers, Lea Launay, Yannick Leaute, Veronique Lion, Danaé Preaux, Fabrice Dupont,	Météo-France	32
BoTo,	Boglarka Toth,	HungaroMet Hungary	5
CoCl, JaFa, RóDa, BrCr	Colm Clancy, James Fannon, Rónán Darcy, Brandon Creagh	MET Eireann	4.25
KrKr,	Kristina Kryžanauskienė,	LHMS Lithuania	2
MoJi, NaMa,	Mohamed Jidane, Najlae Marass,	Maroc Meteo	5
GuNo,	Gunnar Noer,	MET Norway	0.5
MaKo, AgWo,	Marcin Kolonko, Agata Wojtkiewicz,	IMGW Poland	7
JoRi, VaCo, PeSo,	João Rio, Vanda Costa, Pedro Sousa,	IPMA Portugal	1.25
MeAn,	Meda Andrei,	Meteo Romania	0.5
MaLa, JuCe, NePr, TiKo,	Matjaž Ličar, Jure Cedilnik, Neva Pristov, Timotej Kozelj,	ARSO Slovenia	5.5
GeMo, JaCa,	Gema Morales, Javier Calvo,	AEMET Spain	1.5
OnDo, FaBü, MuAc,	Onur Hakan Doğan , Fatih Büyükkasabbaşı, Murat Acar,	MGM Türkiye	8

WP objectives

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 (MQA4.1)
e) interaction with user communities, and facilitating the exchange between users and developers of the ACCORD forecasting systems (MQA4.2, MQA4.3)

The purpose 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 an adequate verification implies making use of spatially distributed data from satellites and radars, 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 parameters related to clouds and microphysics. 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 stratify the verification statistics accordingly.

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 possibilities offered by scientific developments. Because of the enormous diversity of implemented ACCORD forecasting systems user feedback should principally be provided in the form of use cases illustrating important persistent strengths or weaknesses of ACCORD forecasting systems. The MG will reformulate issues reported in terms of meteorological phenomena in terms physical processes, algorithms, initialization or use of observations in an NWP sense, and group together issues of similar nature, and distribute a collection of all the grouped issues among all teams. One or two issues will be selected for further action, giving a higher weight to issues relevant to several CSCs or reported by several teams. For the few issues selected MG will contact NWP key experts as required, define a work plan and frame it within the ACCORD rolling work plan, monitor the progress of the work plan, and report back to the users in appropriate ways. Members are encouraged to nominate user representatives, who will organize the collection of feedback in their respective institutes and form a link between the user community and ACCORD. Groups of Members may agree on a single person to act for the whole group. The user representatives should be staff from the Member NMSs, and active in production of weather forecasts, either as forecasters or serving external customers of their Institute. They should use ACCORD model results for their daily duties, but need not be experts in numerical weather prediction as such.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year		Code contrib to repository	Expected delivery (MM/YY)
					About code deliverables (if any)	
MQA4.1	**Verification of operational systems:** Activities of his task include the production and analysis of verification and diagnostics of operational forecasts and forecasting systems, and the monitoring of observation usage and impact. It is important that the results are documented and shared among Members of the consortium.	ZaBe, NaAb, ChWi, PhSc, AlDe, IdDe, GeSm, JvdB, MiVa, RuMe, EeSa, InEt, LeLa, YaLe, VeLi, JoSt, FaSt, DaPr, FaDu, BoTo, KrKr, MoJi, NaMa, MaKo, MaLa, JuCe, NePr, JaCa, OnDo, FaBü,	Verification reports compiled and presented. New data types and metrics taken on board.			
MQA4.2	**Acting as user representative** The user representatives collect experiences regarding the meteorological performance of ACCORD forecasting systems from colleague forecasters and end users, and complete the ACCORD user feedback form on the behalf of their institute. They identify use cases illustrating persistent or otherwise significant strengths or weaknesses of ACCORD forecasting systems, and liaise with colleagues to compile case descriptions including details about the NWP system dispaying the feature in question and references to related observations and odel output. They distribute among their local user community the response of the ACCORD organization to the collected feedback and participate in ACCORD user meetings.	ZaBe, AlRa, KrNo, AhMe, KeSi, EeSa, FaDu, BoTo, KrKr, GuNo, AgWo, MeAn, TiKo, GeMo, MuAc, BrCr	Feedback forms including use cases			
MQA4.3	**User feedback and interaction:** Activities of this task include supporting the user representative in collecting feedback and compliling use cases, as well as participating in the management and analysis of collected feedback, organizing and providing the response of the ACCORD organization, organizing and participating in user meetings, and in general keeping the user community informed regarding the status and plans for ACCORD systems.	FaDu, BoTo, NePr, GeMo,	Feedback summaries Collected response User meetings			

ACCORD WorkPackage description : MQA5

WP number	**Name of WP**
MQA5	MQA-related Infrastructure
WP main editor	**Claude Fischer, Carl Fortelius, Metodija Shapkalijevski, Daniel Santos-Munoz**
	WORK IN PROGRESS

Table of participants

Participant Abbreviation	**Participant**	**Institute**	**PersonMonth**
DvdB,	Dieter Van Den Bleeken,	RMI Belgium	0.25
DaSa, HeFe, KaHi, LeDe,	Daniel Santos, Henrik Feddersen, Kasper Hintz, Leif Denby,	DMI Denmark	3
LeDe, KaHi,	Leif Denby, Kasper Hintz,	DMI Denmark/D	6
CaFo,	Carl Fortelius,	FMI Finland	2

WP objectives and priorities

We will analyze the design of a work environment supporting MQA-related activities, such as process-oriented validation and verification and the definition of a common HIW benchmark. In this environment model outcome can be easily evaluated against observations, e.g., from supersites and research networks such as Cloudnet, as well as output from Large Eddy Simulation (LES) models. For the sake of clarity, the goal is not to organize and make data available to end users. The goal is to organize and make available data under commonly agreed formats, along with tools and methodologies, suitable for model development (R&D) and enabling ACCORD to assess the added value of its HR models.
This activity has links with the RWP WPs MQA2-MQA3-MQA4-PH5 and requires strong competence from System. It will also require management and governance actions.

We will envisage to prototype a solution, which might not yet include all elements of a long term solution, with the aim to:
- evaluate technical choices with concrete examples
- bring our scientists to participate in common MQA work and collect their feedback (learn from the process)
- assess the needs for the long term: which functions and/or tools are most useful, what internal data policy to adopt (duration of storage versus growth of the size of an archive etc.), how to link a data portal with some computational resources
- consolidate the resource requirements perhaps with scenarii of different cost. The resources might include both staffing and financial resources

The needs with respect to also using the MQA-infrastructure for the evaluation of ML tools (ie data driven forecast models) will be taken into account.

Following the progress in the design effort, the needs for a Data Manager will be evaluated. A specific management task will be to communicate and prepare rationale(s) for governance decisions, especially regarding resources.
This whole activity is defined in coherence with the proposals in the ACCORD 2026-2030 draft scientific strategy.

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)**
MQA5.1	Study a prototype of the work environment				
MQA5.2	Analyze the needs for using the MQA-benchmark and the MQA-infrastructure for the evaluation of data driven models	DvdB, HeFe, KaHi, LeDe, CaFo,			
MQA5.3	Pending on progress in the design, evaluate the resource requirements that may require governance discussions	PM			
MQA5.4					
MQA5.5					

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	0.5
NiSo, MiHa,	Niko Sokka, Mikael Hasu,	FMI Finland/D	4
RyEl, SoBi,	Ryad El Khatib, Soline Bielli,	Météo-France	4
RiJa,	Rimvydas Jasinskas,	LHMS Lithuania	3
OlSp,	Oldrich Spaniel,	SHMU Slovakia	4

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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.h**	**Type of deliverablei**	**Code contrib to repository**	**Expected delivery (MM/YY)**
SY1.1	**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.	NiSo, MiHa, RyEl, RiJa, (	T-code?		
SY1.2	**4DVar profiling and optimization for operational uses**. Extension zone redefinition. The 4DVar code is available in cy43h2.2 and phased to cy46/cy48/cy49	DaSa,	Non-t-code		
SY1.3	**Further studies with single-precision versions of the NWP codes for the forecast models, including EPS configurations.** - 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, SoBi, RiJa,	t-code		
SY1.4	**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	OlSp,	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, KaHi, MaDa, SoNi , MaFr,	Daniel Santos, Kasper Hintz, Mats Dahlbom, Søren Borg Nielsen, Martin Lyskjær Frølund,	DMI Denmark	7.25
EoWh, RóDa, CoDa,	Eoin Whelan, Rónán Darcy, Conor Daly,	MET Eireann	6.5
BeUl,	Bert van Ulft,	KNMI Netherlands	1
JaSn, CrRo,	Jacob Snoeijer, Chris Romick,	KNMI Netherlands/D	5
OlVi,	Ole Vignes,	MET Norway	1
PaEs,	Pau Escriba,	AEMET Spain	1.5
DaYa, PaSa,	Daniel Yazgi, Patrick Samuelsson,	SMHI Sweden	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 version declaration proccess, 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 this centers is to ensure and demonstrate the technical and meteorological capability of the model in an operational environment. Until 2016 the commitment only involved the deterministic model, but as HarmonEPS is nowadays an integral part of the system it has been. Pre-release testing of new Reference releases is done at least on the 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 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) required some effort to establish new working practices and migrate code repositories, including associated documentation. Continuing with such efforts we plan to split the common source codes from the scripting and tools. This process will allow us to create a harmonie branch directly in the IAL repository and thanks to the bundling tool the generation of the harmonie system by checking out and linking the scripting and tools from separate repos.

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

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
SY2.1	**Establish a procedure between Hirlam services and the operational groupings to test and run a Harmonie reference for CY49**	DaSa, KaHi, SoNi , MaFr, EoWh, JaSn,	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, BeUl, CrRo,	Non-t-code	other repo	
SY2.3	**Test injection of observation data at ECMWF and operational platforms for the Harmonie reference**		Non-t-code	other repo	
SY2.4	**Ensure platform equivalence between the Reference system at ECMWF and operational 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.	DaSa,			
SY2.6	**HIRLAM GitHub:** - Continue promoting and establish new work practices that will facilitate a more efficient and continous code integration such using more test during the pull request acceptance process using GitHub actions and also enabling the capability of launching the Testbed and/or Davai from GitHub. - Continue the migration of code documentation from the hirlam.org wiki to GitHub and improving the practices on the documentation apects, establishing a control about the documentation provided in each new feature. - Different levels of training to ensure a good transfer of knowledge about git and GitHub. Such training activities will be done by in-situ talks during the tematic Working Weaks and in special webinar events. - Use the new capabilities that the GitHub Team plan offers like wiki in private repos and increase the number of actions that can be triggered.	DaSa, DaYa, PaSa,	Non-t-code	other repo	

SY2.7	**Build on the multi-repository strategy:** - Separate the common source code from the rest of the scripting and harmonie tools. - Use a branch in the IAL repository to generate a version of harmonie from cy49 and cy50 - Use the bundling tool to generate the complete system including compilation tool, scripting system and associated tools. - Establish working procedures in GitHub that allow the necessary synchronization of repositories in the case of contributions that require changes in source code, scripiting and/or tools. - Build a prototype for, obsmon, gl and pysurfex as external tools available to the entire consortium.	OlVi,	T-code	IAL	
SY2.8	**Tiger team for CY50 specific tasks:** - Cross-check the Harmonie Reference components are present in T and integrate them in the Th branch - Design Davaï test for each Harmonie contribution - Accelerate the Harmonie-49Th1 declaration through block and system testing - Introduce MQA workflow (HARP based) for block and system testing to create Harmonie-export version which produces meteorologically reasonable results, as code base for scientists to build upon (no full MQA and optimization for operations yet - Prototype for ACCORD a basic working environment for harmonie that can be used as ALL CSC Export version based on DE_330 scripting and architecture	DaSa, MaDa,	T-code	DAVAI-tests	
SY2.9	**Implement Harmonie CSC test in Davaï testing tool on ECMWF for CY49/CY50**	DaSa, CrRo,	Non-t-code	DAVAI-tests	
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. - FullPos: Reuse DE_330 knowledge to 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, also for he preparation of boundary conditions, or evaluate the possible implementation of the gl 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. - zarr format output: Explore the possibility of implementing the zarr format as a more suitable output format for ML/IA directly in the Harmonie suites. - PGD optimization for large or on demand domains from DE_330 developments	DaSa, KaHi, SoNi , MaFr,	Non-t-code	other repo	
SY2.11	**More portable versions of harmonie** - Working on Containers using (rootless) for MUSC and Harmonie CY46/CY49	EoWh,	Non-t-code	other repo	
SY2.12	I**mplementation of Titan/GridPP primarily as part of HR setups and crowdsourced data and also for new surface physics**. Evaluate them as a possible Canari replacement tool.		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.		Non-t-code	harp	
SY2.14	**Continue de CMAKE implementation as default compilation tool for Harmonie**		Non-t-code	other repo	
SY2.15	**Continue with the scripting and methodology adaptations for sub hourly cycling and DA**		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,	GEOSPHERE Austria/D	1
AlDe,	Alex Deckmyn,	RMI Belgium	3
MiTs, KoMl, MiPa,	Milen Tsankov, Konstantin Mladenov, Mihail Parvanov,	NIMH Bulgaria/D	12
DaSa, XiYa,	Daniel Santos, Xiaohua Yang,	DMI Denmark	2.5
XiYa, SoNi ,	Xiaohua Yang, Søren Borg Nielsen,	DMI Denmark/D	1.5
AlMa, ThLe,	Alexandre Mary, Thibault Lestang,	Météo-France	4.5
JaSn, CrRo,	Jacob Snoeijer, Chris Romick,	KNMI Netherlands/D	3
RoSt,	Roel Stappers,	MET Norway	6
MiPa, MiPa,	Miguel Pardal, Miguel Pardal,	IPMA Portugal/D	7
BeSt,	Benedikt Strajnar,	ARSO Slovenia	1
UlAn,	Ulf Andrae,	SMHI Sweden/D	2

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. The DEODE WP5 engine has been considered a good candidate to be the base of the common scripting system. The consultation with ECMWF about the possible use of the codes by ACCORD has been opened by the Destination Earth partners (the legal property of WP5 deliverables is to the EU Commission, ECMWF acting as an intermediate Entity with DE partners).

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)**
SY4.1	**Establish a procedure for the design and co-development between ACCORD and DE_330 of components not initially present in the DEODE workflow,** with special emphasis on their use for research purposes although ideally they could be used in operations.	KoMl, MiPa, SoNi , JaSn, BeSt, UlAn,			
SY4.2	**Establish a transfer of knowledge between the different scripting systems and their possible synergies:** - Establish a transfer of knowledge between ACCORD and DEODE workflow - Continue the transfer of knowledge initiated under DAP2024 of the Vortex scripting as a base for Davai and other components not present today in DEODE workflow	MiTs, KoMl, MiPa, DaSa, XiYa, AlMa, ThLe, CrRo, UlAn,		other repo	