ACCORD
A Consortium for COnvection-scale modelling Research and Development

Rolling Work Plan 2026

Introduction to the RWP2026

The following pages of the RWP2026 contain the work package presentations of the ACCORD activity planned in 2026, 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 2025 (discuss main changes with respect to the RWP2025, 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 2025, 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

With the start of phase 2 in 2026, part of the MG and the Support Team will be renewed. The transition of the old to the new management is intended to be organized in a smooth manner. Regarding the RWP2026, while it has been formulated by the old MG, its execution and monitoring will be done by the new MG. Such a continuous transition in terms of RWP content and realization is expected to be largely facilitated by the mere fact that people in

WPs and in teams remain much the same, just as many WP Co-editors will remain. In addition, some joint meeting between leaving and new MG members will be arranged for a specific handover. Finally, the RWP2026 reflects the goals of the Scientific Strategy for the first year of phase 2 (see the subsection Link of the RWP2026 with the 2026-2030 scientific strategy proposal).

At the time of writing this introductory section, the exact number and nature of the empty MG (Area Leader) positions is not yet known. Should there be empty positions at the beginning of 2026, then specific management adaptations will have to be decided and implemented, likely on a case-by-case basis. The first instance of such a discussion probably would be the ACCORD Assembly meeting of 1-2 December where a general outline of a proposal could be presented.

Fairly similar remarks hold for the future work on documentation (with the next Documentation Officer) and the role of the Coordinator for Networking Activities (CNA). For the CNA role, the possibility of not having a person filling the position in January 2026 is an unfortunate yet real possibility. Such a situation also would call for a specific analysis on how to deal with the absence of a CNA who has a specific role in connection with the RWP (especially in **COM3.1**).

A few words on the drafting of the RWP2026

The MG has decided to adapt the structure of the RWP and of the WPs in just a few places. A novelty this year is the definition of a number of priority topics which have been drafted by the MG, presented to the LTMs (September 2025) and included within the RWP document (see sheet "***Priorities***"). The defined priorities span over all Areas in order to give all the teams and their institutes an insight into a variety of topics and of tasks where their involvement is highly encouraged (possibly by re-prioritization of their expected research activity).

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 2025) for next year, involving the usual intensive interactions with the teams. The main places of adaptation of the RWP2026, with respect to its 2025 version, are:

- The WP about documentation **COM4** has been completely overhauled with respect to RWP2025, taking into account the effective start of basically all expected development lines (welcome pack, namelists, scientific doc of the code, inventory of existing documentation elsewhere etc.)
- The system and code WP **SY4** has been redefined in order to reflect the 2026 tasks planned in the Common Scripting System (CSSy) roadmap adopted by the A/A in July 2025

A first draft version of the RWP2026 was made available to the LTMs in the beginning of July, 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 RWP2026, using a dedicated table under the responsibility of the ACCORD/CSS.

Link of the RWP2026 with the 2026-2030 scientific strategy proposal

Given the changes implemented in the RWP2025 and RWP2026, many of the tasks now reflect the consequences of the Scientific Strategy adopted in December 2024. As an example, one may pinpoint to WP **MQA5**, where it is proposed to consolidate the prototyping of the MQA-infrastructure fit for process-oriented and high-impact weather validation.

Tasks in the core scientific WPs (in dynamics, physics, surface, DA, EPS) as well as in **CRA** (code refactoring and adaptation) also come in reflection of the 2026-2030 Strategy. In common activities (**COM2**) and in System (especially **SY4**), a number of tasks relate to key strategic elements needed for the enhancement of the common development environment proposed in the new strategy. Of particular interest will be the further modernization of the working practices and tools related to them, as well as the common scripting system and ancillary components of the stackflow.

Machine Learning and AI activities described in this RWP

ACCORD teams show 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 RWP2026, especially in data assimilation and EPS, however also in relation to physics parameterizations and surface. A few specific task descriptions have been removed from the RWP2026 (in comparison with 2025) since it appeared that no team actually had started any activity on them (in physics: microphysics and turbulence).

The list of WPs and tasks where ML appears is given hereafter for information:

- ***COM2.T.10***: 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
- ***PH2.11***: ML to emulate/accelerate 3D radiation
- ***SU1.8.2***: Exploring a possibility of using ML methods for observation operators. See also ***DA9.3***
- ***SU4.17***: Forecast uncertainty estimation for very-high resolution stand-alone SURFEX (100m grid) by emulating ML-based ensemble members
- ***SU5.6***: Hectometric scale cover map for Europe
- ***E6.4***: Generation and downscaling of ensemble members by deep learning approaches (diffusion-based models)
- ***E6.5***: ML-based calibration and post-processing
- ***E7.1***: Objective identification of convection objects and of severe storms in ensemble outputs, using convolutional neural networks. Development of a deep-learning based clustering of ensemble members to identify a small number of informative scenarii, application to heavy rainfall events
- ***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
- ***MQA5.3***: 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 RWP2026, 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.

The precise content of phase 3 of DEODE is not yet known at the time of writing this introduction. The intersection and the impact of the work plans of phase 3 with ACCORD will be studied in spring 2026.

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.

Manpower and expertise points of attention

Several points of attention regarding the evolution of expertise and manpower have been identified by the MG during the preparation of the RWP2026. They are listed hereafter for the attention of STAC and for further liaison with the ACCORD governance.

- Code management and system:
  - Maintaining the DAVAÏ-developers team: since 2023, ACCORD has a fairly sustained team of 4-5 people (about 0.1 FTE each) under the lead of the Integration Leader. Given the central role of the DAVAÏ tool for testing code contributions during the integration process of new options, it is very important for ACCORD to be able to maintain this expertise and staffing during the next years. This team also could play an important role in the implementation of a strategy for continuous integration/continuous development (CI/CD) of new code versions in the next few years.
  - Building a "Scripting experts team": According to the "scripting roadmap" approved by the A/A in July 2025, a small team (of about 4-5, 0.1-0.2 FTE each) should be created, who will develop and maintain these scripts. These people will become experts of the new scripting codes as such (i.e. the functions and the code for implementing them), but they also will build an expertise on other existing tools of interest for the CSSy as well as on HPC environments.
  - Identifying (and nominating) a code co-integrator for SURFEX: the role of "code co-integrator" has been defined in the MoU2 (Annex VI). We will look after such a person with the tasks to support the preparation of code contributions from the NWP teams to the SURFEX code repository, to run the SURFEX test bench ("STRATO") and to liaise when needed with the scientists (under the supervision of the Integration Leader and of the Surface Area Leader). Over time (after a year?), the person could change and the expertise could be handed over to the next colleague.
- MQA-infrastructure: A key priority for 2026 is to establish this infrastructure as an integral part of the common ACCORD system resources and to further develop it based on lessons learned from the prototype. Achieving this goal will require strong support from System experts in particular, as well as from ACCORD governance to address potential administrative challenges.
- Code refactoring and adaptation (CRA), continued activity on code modernization: expertise and resources on CRA appear to be dwindling at ACCORD level. In 2025, only 3 institutes have been intensively contributing with resources and ***their strong involvement definitely should be vigorously acknowledged*** (MF, RMI, Met Norway). Although forming a fair small team, the involved staff was able to develop a significant expertise and achieved remarkable progress also supported by DEODE funding (see the CRA section in the scientific reporting 2025). In 2026, the expectation based on the manpower commitments is that only 2 institutes would remain intensively active, and that the global manpower figure would decrease. If

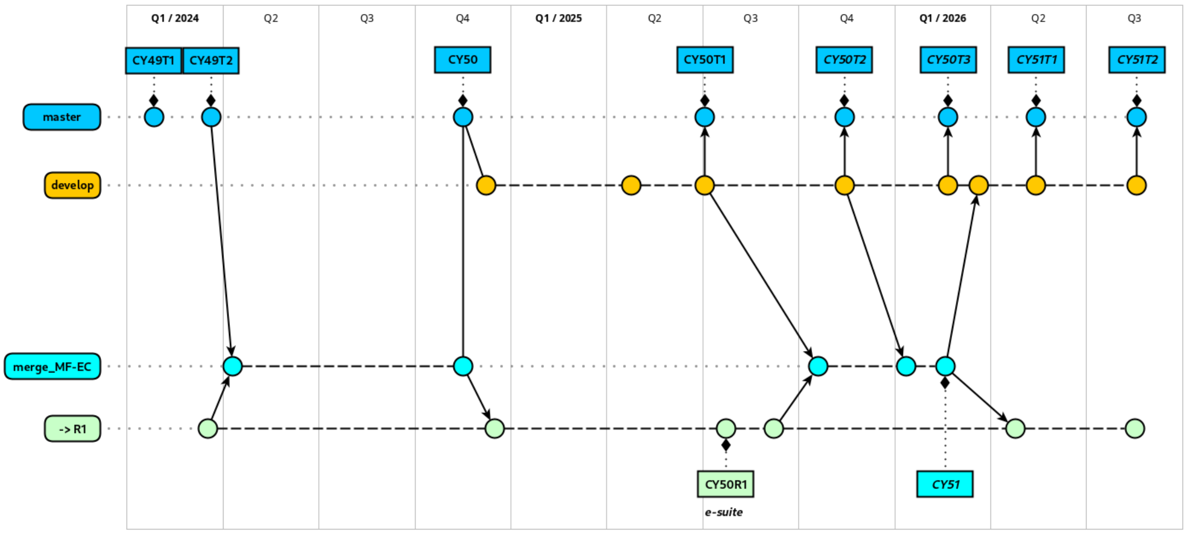
confirmed, this evolution would likely slow down the progress of the remaining work on GPU adaptation. Moreover, it would question the level of involvement of ACCORD in further modernization steps of the common codes for instance in relation with the "IFS software strategy" under discussion at ECMWF (refer to ECMWF SAC papers).

- Dynamics: manpower should be increased in order to test some of the options developed over the past few years (e.g. Vertical Finite Elements) as well as for strengthening the testing of the FVM model (Finite Volume Model, shared with ECMWF and other international partners). A key question is to evaluate to what extent FVM could meet our very high resolution needs.

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 2026

For each Work Package, the total manpower committed for 2026 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	66.75	0
COM	COM2.1	Code generation and maintenance: regular maintenance and evolutions, official releases	38	1
	COM2.T	Code generation and maintenance: Transition to new work practices and environment	13	0
	COM3.1	Maintenance and Partners' implementations of the ACCORD system	68.5	0
	COM3.3	Training (preparation, lectures, attendance)	0	0
	COM3.4	Attendance and preparation of ASW & EWGLAM	10	0
	COM4	Common effort on documentation	3.5	0

Transversal software developments	CRA	Code Refactoring and Adaptation (formerly SPTR)	45.5	21.5
Towards modelling at (sub-)km resolution	HR	Sub-km modelling	31.5	9
Dynamics	DY1	Improvement of SISL spectral dynamical core (H and NH)	34	9
	DY2	FVM-like solution as an alternative to SISL dynamical core	4.5	1
	DY3	Development of methods for solving the implicit equation in gridpoint space	2.75	2
Data Assimilation	DA1	In-situ observations	47	0.5
	DA2	Use of ground-based remote sensing	66.25	0
	DA3	Satellite-based remote sensing observations	127	0
	DA4	Observation pre-processing, quality control, bias correction and representation error	18	0
	DA5	Variational systems, e.g. with 3D-Var or 4D-Var	44.25	0.25
	DA6	EnVar, EDA and variants	55	0
	DA7	Initialization methods and nowcasting	7.5	0
	DA8	Diagnostic methods, optimization of assimilation cycling	22.75	0
	DA9	AI/ML methods for data assimilation	23.5	0
Physics parametrizations	PH1	Turbulence & shallow convection	48.5	5
	PH2	Radiation	20.5	0
	PH3	Clouds-precipitation microphysics	51.75	0
	PH4	Common 1D MUSC framework for parametrization validation	2.75	0
	PH5	Model Output Postprocessing Parameters	24.75	0
	PH6	Study the cloud/aerosol/radiation (CAR) interactions	21.5	0
	PH7	On the interface between the surface and the atmosphere	9.75	0.75
	PH8	On the interface of Physics with Dynamics (and time stepping)	1.5	0
Surface analysis and modelling	SU1	Surface data assimilation	57	0
	SU3	SURFEX: validation and development of existing components for NWP	73.5	3
	SU4	SURFEX: development of new model components	5.5	0
	SU5	Assess/improve quality of surface characterization	22.75	3
	SU6	Coupling with sea surface/ocean	13.625	0
Ensemble forecasting and predictability	E6	Ensemble calibration by use of machine learning and deep learning algorithms	38	10
	E7	Develop user-oriented approaches	66.25	0

	E8	EPS preparation, evolution and migration	38.25	0.75
	E9	Model perturbations	41	2
	E10	Initial condition perturbations	4	0
	E11	Surface perturbations	10.75	0
	E12	Lateral boundary perturbations	10	0
Meteorological quality assurance and verification	MQA1	Development of HARP	9.75	0
	MQA2	Development of new methods for verification and validation	31	2
	MQA3	Model validation and error attribution	92.25	1.25
	MQA4	Verification of operational forecasts and user interaction	102.75	0
	MQA5	MQA-related Infrastructure	10	0
Technical code and system development	SY1	Code performance portability	22	2
	SY2	Maintenance and development of the Harmonie Reference System	20.75	1
	SY4	Roadmap tasks for developing an ACCORD common scripting	48.75	39.25

Table of priority topics from the RWP-2026 highlighted by MG

AREA	Topic short description	Reference in the RWP2026
DA	Local installation of OOPS based on CY48 or CY49. Cross support within DA Area using those teams who already are experienced with the porting.	DA5 (DA5.1, DA5.2, DA5.4)
	High interest for the teams to get started with processing MTG data locally (IRS etc.). Remind that they will need preprocessing tools in order to decompress the data.	DA3 (DA3.3)
MQA	Engage in the evaluation and inter-comparison of data driven models with physics-based models, with a focus on understanding the physical relevance of the results with AI models (for those teams who have access to results of AI models).	MQA5.3 & MQA3.3
	Staffing and participation in the build of the MQA-Infrastructure.	The whole WP MQA5
	Encouragement to install and use the common scripting for using harp locally for verification (experimental and/or operational).	MQA1.4
CRA	Code refactoring: focus on the “diagnostic part” of the forecast model: IO, DDH, FullPos. This will require analysis first!	CRA1.3
	Develop testing and integration facilities. Testing and integration: integration of source-to-source translation in build system; GPU-build in Davai; GPU-run in Davai (?)	CRA5
SY	The tasks for implementing the common scripting roadmap.	SY4
SY/COM	The move toward Continuous Integration (CI).	COM2.1.12
COM	The transfer of knowledge (DAVAÏ and other tools).	COM2.1 (COM2.1.13) & COM3.3
	Making scientific documentation of the code	COM4.4
PH	Due to (strongly) decreased manpower in 2026, priority has been put on proper evaluation/setups of existing parameterizations (shallow-convection, turbulence, microphysics and CAR) with respect to operational NWP questions raised by forecaster feedbacks	PH1, PH3, PH6, MQA3.2
	Process-oriented (physics-based) model validation is important across the WPs (link to MQA priority)	Physics WPs, MQA5
SU	There is clear interest/support among surface editors for a WW dedicated to how to progress with OOPS for surface data assimilation. A session with this subject will be planned for the autumn online-only ACCORD surface WW and an in-person WW will follow 2026. Not yet clear whether this WW should coincide with the general surface in-person WW in Prague or be a separate WW coordinated with the DA team.	SU1.6 & DA6.4
EPS	Include EPS functionality in the common scripting system.	E8.14, SY4
	Continue development and validation of stochastic parameter perturbations (SPP), especially perturbations of surface parameters and flow-dependent SPP. Test the use of the URANIE uncertainty and sensitivity framework for selection and tuning of parameter perturbations.	Most of E9, E11.1, E11.3
DY	Vertical finite elements (Non-hydrostatic): Currently this option is not working properly. Stability remains an issue. We should be doing more testing in order to better understand the issues. Some additional manpower for running experiments and analyzing their outputs would be highly appreciated.	DY1.1
	Insufficient manpower on new FVM task. FVM provides the only other (alternative) possible dynamics that we have in our plans, however we are not sure at all whether FVM really is an interesting alternative for the future. More investigation on the potential of FVM is needed. For the time being, there’s only 1 person (DEODE funding) working on FVM but feeling alone on the topic despite help from some experts (who are otherwise busy as well). Note: This activity depends on the new version from ECMWF we are waiting for.	DY2.1

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
StSc,	Stefan Schneider,	GEOSPHERE Austria	1
AlDe,	Alex Deckmyn,	RMI Belgium	0.5
MaTu,	Martina Tudor,	DHMZ Croatia	5
JuSo, DaSa, ToBe,	Julia Sommer, Daniel Santos, Tommaso Benacchio,	DMI Denmark	6.5
AhMe,	Ahto Mets,	ESTEA Estonia	1
ReEr,	Reima Eresmaa,	FMI Finland	0.5
ErEs, CéLo, AlMa, ErBa,	Eric Escaliere, Cécile Loo, Alexandre Mary, Eric Bazile,	Météo-France	10.5
GaSz,	Gabriella Szepszo,	HungaroMet Hungary	1
GNPe,	Guðrún Nína Petersen,	IMO Iceland	0.25
SaVa,	Saji Varghese,	MET Eireann	1
RiJa,	Rimvydas Jasinskas,	LHMS Lithuania	1
SiSb,	Siham Sbii,	Maroc Meteo	1
WdR,	Wim de Rooy,	KNMI Netherlands	1
BoBo,	Bogdan Bochenek,	IMGW Poland	2
AlCr,	Alexandra Craciun,	Meteo Romania	1
AnSi,	Andre Simon,	SHMU Slovakia	0.5
JuCe,	Jure Cedilnik,	ARSO Slovenia	1
MeSh, PaSa,	Metodija Shapkalijevski, Patrick Samuelsson,	SMHI Sweden	1
WaKh,	Wafa Khalfaoui,	INM Tunisia	1
YeCe,	Yelis Cengiz,	MGM Türkiye	1
LTMs	Local Team Manager	NIMH Bulgaria	1
LTMs	Local Team Manager	DHMZ Croatia	1
LTMs	Local Team Manager	CHMI Czech	1
LTMs	Local Team Manager	MET Norway	1
LTMs	Local Team Manager	IPMA Portugal	1
LTMs	Local Team Manager	AEMET Spain	1
LTMs	Local Team Manager	SMHI Sweden	1

WP objectives and priorities

This WP sheet describes the tasks and manpower requested for the Management of the ACCORD consortium. The tasks are summarized from the Terms of Reference defined in the MoU-2. 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

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
MNGT4.1	Execution of GA decisions	MoMo, StSc, AlDe, MaTu, JuSo, DaSa, ToBe, MaMe, ReEr, PM, ErEs, CéLo, GaSz, GNPe, SaVa, RiJa, SiSb, BoBo, AlCr, AnSi, JuCe, WaKh, YeCe,			
MNGT4.2	Organisation, coordination, minutes of the GA, STAC, PAC, MG meetings	PM, CSS,	preparatory documents, minutes & recommendations		
MNGT4.3	Elaboration and execution of the RWP, reporting to the GA	PM, CSS,	RWP submitted to GA		
MNGT4.4	Preparation and execution of the annual budget	PM, 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, WdR,	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	PM,			
MNGT4.8	Maintenance of the Consortium official web-site where all the relevant information about the project is published	CSS,	website		
MNGT4.9	Scientific & technical coordination within the 8 topical Areas, implementation of corresponding goals of the Strategy, implementation of RWP tasks, coordination with the CSC Leaders	MaTu, AlMa,			

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, DaSa,			
MNGT4.11	Communication and coordination of operational changes of the common system (ARPEGE-AROME) in MF	CéLo,			
MNGT4.12	Coordination of the Consortium activities of their respective national project teams (Local Team Manager tasks)	StSc, AlDe, MaTu, JuSo, ToBe, MaMe, ReEr, GaSz, GNPe, SaVa, RiJa, SiSb, BoBo, AlCr, AnSi, JuCe, 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)				
MNGT4.15	Participation in the new ACCORD Working Group for information and communication on AI/ML activities (**WG-InComAI**). *the creation of the WG has been approved by the A/A (7/7/25) - the members of the WG are expected to be nominated by the A/A (ie they will not be upon proposal by the teams)*	BoBo,	a yearly report for sharing with STAC and the MG		

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	2
DaDe,	Daan Degrauwe,	RMI Belgium	1
DeHa,	Denis Haumont,	RMI Belgium/D	1
RyEl, HaPe, FaVo, ThLe, AlMa, PaSa, FlSu, StMa, PaMo, ChPa,	Ryad El Khatib, Harold Petithomme, Fabrice Voitus, Thibault Lestang, Alexandre Mary, Patrick Saez, Florian Suzat, Stephane Martinez, Patrick Moll, Christophe Payan,	Météo-France	26.5
DaLa,	David Lancz,	HungaroMet Hungary	0.5
OlSp,	Oldrich Spaniel,	SHMU Slovakia	2
DaYa, PaSa, SwMa,	Daniel Yazgi, Patrick Samuelsson, Swapan Mallick,	SMHI Sweden	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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**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, RyEl, HaPe, FaVo, AlMa,	(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.	RyEl, HaPe, FaVo, AlMa,	New release CY51 or CY52	IAL	31/12/2026
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) - Elaboration of the documentation for the Pull Request to the source code forge	RyEl, HaPe, FaVo, AlMa,	Contributions to CY51T*	IAL	continuous effort
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	AlMa,	New releases CY50T*, CY51T*	IAL	
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.	ThLe, AlMa, PaSa, FlSu, DaLa,	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, FlSu,	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	AlMa,	PR template update(s)		
COM2.1.10 (ex-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-bundle	continuous effort

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)	AlMa,	A lively forge		continuous effort
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.	AlMa,	Documentation		
COM2.1.13	**Training about these tools/practices** Git (ACCORD forge), Davaï, bundling	AlMa,	Trainings sessions + supports		
COM2.1.14	**Integration of SURFEX v49T1 in V9.2** Merge of v49T1 with V9 has been done already in 2025, validation under progress. Remaining work is: - finish validation in offline mode, incl. code review - merge with V9.1 additions and re-perform validation in offline mode	AlMa,	V9.2	Surfex-NWP	
COM2.1.15	**Code co-integrator tasks for SURFEX.** Preparation of the SURFEX code contributions for integration in a new branch of the SURFEX repository, after the migration of SURFEX to GITHUB and after the creation of an NWP branch based on V9.2. Testing the contributions with STRATO. Liaison with the scientists as required, uner the supervision of the IL and of the Surface AL.		V9.3 or later	Surfex-NWP	

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
AlDe, IdDe,	Alex Deckmyn, Idir Dehmous,	RMI Belgium	1.5
BoTs, MiPa,	Boryana Tsenova, Mihail Parvanov,	NIMH Bulgaria	4
LeDe,	Leif Denby,	DMI Denmark	1.5
AlMa,	Alexandre Mary,	Météo-France	1
MaMo,	Maria Monteiro,	IPMA Portugal	3
ZeÜn,	Zeynep Feriha Ünal,	MGM Türkiye	2

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.2 > COM2.1.10	~~**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.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.		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	**Define and Assess a Potential "All-CSC" Export Code Version** Evaluate the feasibility of developing a unified "all-CSC" export code version aimed at accelerating both research and operational adoption of selected cycles. This version should ensure a baseline level of meteorological quality assurance and include agreed CSC reference settings (e.g., namelist configuration). - Define the concept clearly – What does an "all-CSC export version" entail in practical terms? - Evaluate technical and procedural requirements – Focus on automatisation and validation aspects. - Present the concept to relevant teams to gather feedback, assess interest, and identify potential contributors or obstacles to implementation.	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, MaMo, ZeÜn,	reporting by DAsKIT teams during the DA WWs, during the DAsKIT specific online meetings, possibly within the ACCORD Newsletter		
COM2.T.8	**Coding norms checking using lintering tools** - Explore the possible use of Loki for norm checking				
COM2.T.9	**Use of GitHub actions to run tests in remote machines** - Explore the use of GitHub actions to run lintering tools, compilation, technical testing at remote machines. - Use the knowledge from harmonie-arome CSC reflected in SY2.6	BoTs, MiPa,			
COM2.T.10	**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.	LeDe,	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**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
WaCh, AyMe,	Walid Chikhi, Ayoub Mehbali,	ONM Algeria	2
FlWe, BrGo,	Florian Weidle, Brigitta Goger,	GEOSPHERE Austria	3.5
AlDe,	Alex Deckmyn,	RMI Belgium	1
MaTu,	Martina Tudor,	DHMZ Croatia	1
AnBu, AlTr, RaBr, PeJa,	Antonín Bučánek, Alena Trojáková, Radmila Brožková, Petr Janeček,	CHMI Czech	12
PeEl, DaLa, HeKo,	Peter Elek, David Lancz, Helga Kollathne Toth,	HungaroMet Hungary	8
GNPe, BoPa, XiZh, KrGu,	Guðrún Nína Petersen, Bolli Pálmason, Xiaohui Zhao, Kristinn Guðnason,	IMO Iceland	5
BaSa,	Badr Sabir,	Maroc Meteo	3
RaGr, OlVi, EiSt,	Rafael Grote, Ole Vignes, Eivind Støylen,	MET Norway	6
SiTa, AlCr, AlCr, MiOp,	Simona Tascu, Alexandra Craciun, Alexandra Craciun, Mihail Oprea,	Meteo Romania	8.5
AnSi, OlSp,	Andre Simon, Oldrich Spaniel,	SHMU Slovakia	2
MaLa, JuCe, NePr,	Matjaž Ličar, Jure Cedilnik, Neva Pristov,	ARSO Slovenia	5.5
AlCa, JuGo,	Alfons Callado , Juan Gomez Navarro,	AEMET Spain	2
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	5
OnDo, ZeÜn, CeKı,	Onur Hakan Doğan , Zeynep Feriha Ünal, Celaleddin Kızılkaya,	MGM Türkiye	6

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/UWC 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.[4-5] 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	About code deliverables (if any): 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.	BaSa,			
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/UWC 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, SiTa, AlCr, MiOp, MaLa, JuCe, NePr, OnDo, 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**)	FlWe, BrGo, AnBu, AlTr, RaBr, PeJa, PeEl, DaLa, HeKo, GNPe, XiZh, KrGu, BaSa, RaGr, OlVi, EiSt, AnSi,	(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	AnSi,	minutes from LTM meetings		
COM3.1.5	Coordination of MF operational changes with Partners	AnSi,	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

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.		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
MaTu,	Martina Tudor,	DHMZ Croatia	1
ReEr,	Reima Eresmaa,	FMI Finland	0.5
CSS, CéLo,	Anne-Lise Dhomps, Cécile Loo,	Météo-France	2
GaSz,	Gabriella Szepszo,	HungaroMet Hungary	0.5
GNPe, BoPa, XiZh, KrGu,	Guðrún Nína Petersen, Bolli Pálmason, Xiaohui Zhao, Kristinn Guðnason,	IMO Iceland	3
SiTa, MiOp,	Simona Tascu, Mihail Oprea,	Meteo Romania	1
AnSi, OlSp,	Andre Simon, Oldrich Spaniel,	SHMU Slovakia	1
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

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
COM3.4.1	Preparation of the meeting (venue or online and programme)	CSS,	programme, list of participants, any published information or organisational note about the venue		
COM3.4.2	Preparation and presentation of national poster	CéLo, GaSz, BoPa, XiZh, KrGu, SiTa, AlCr, MiOp, JuCe,	national poster		
COM3.4.3	Attendance	ReEr, CéLo, GaSz, GNPe, BoPa, XiZh, KrGu, SiTa, AlCr, MiOp, AnSi, JuCe,			
COM3.4.4	Preparation of Newsletter contribution	GNPe, BoPa, XiZh, KrGu, SiTa, AlCr, MiOp,	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	
PM	Claude Fischer	(not relevant)	
CSS	Anne-Lise Dhomps	Météo-France	
MaTu,	Martina Tudor,	DHMZ Croatia	1
JeOn,	Jeanette Onvlee,	KNMI Netherlands	1
BeSt,	Benedikt Strajnar,	ARSO Slovenia	1.5
TEAMS	Any staff from the teams as agreed in the yearly plans within each Area		

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)
6. Organizing documentation across the NWP collaboration and sharing a common referencing with ECMWF, MF and other ACCORD families (eg LACE, Hirlam/UWC)

Documentation has also been explicitly referenced as a goal in the ACCORD Scientific Strategy 2026-2030, as approved in December 2024. The goals of this WP therefore 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.

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**. Regarding the formal (and practical!) definition of manpower, the following commitment/registration practices are proposed:
1. the production of documentation close to the codes, especially for Pull Requests to the common source code forge, shall be considered as part of the preparation of a code contribution in **COM2.1**
2. the elaboration by staff members of documentation listed under items 2-5 above can be considered as part of **COM4** (Task **COM4.4**)
3. if there is any reason for not accounting work time on documentation in this WP **COM4** (for instance because of external funding requirements), the manpower can either be implicit within a scientific WP or not accounted for at all
4. some management efforts on documentation will be part of **MNGT4** (PM, CSS)

In addition to documentation per se, we also will investigate and maintain tools to enhance communication and information across the consortium.

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

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)
COM4.1	Organization of existing and new documentation and its maintenance.	DO	After prototyping in 2025, it's expected that a stable solution for the organization of the scientific doc is in place in 2026.		
COM4.2	Provide support to: 1. the organization of the ACCORD documentation in close coordination with the MG and other key scientists in the consortium 2. the ACCORD/CSS on the elaboration of the consortium Newsletter, and on documentation hosted in the consortium website 3. the PM or to MG members on the elaboration of communication and publication material	DO			
COM4.3	Across the NWP collaboration: 1. Maintain an inventory of the documentary funds, including the link with IFS (ECMWF) and Arpege (Météo-France)., 2. Organize the sharing of a common referencing with ECMWF, MF and other ACCORD families (eg LACE, Hirlam/UWC)	DO, CSS, PM	At least one joint meeting with ECMWF and MF doc representatives has taken place		
COM4.4	Participate in the planning and the elaboration of new documentation of the following four types: 1. Scientific Documentation of the codes (to be specific: writing documentation under the coord of the DO and of the MG is a work included in this task, regardless of the topic or the area or the code component), 2. Tutorials and How To's, 3. Meteorological Quality Assurance Documentation, 4. Technical Documentation of ancillary common Tools	DO, PM, TEAMS, MaTu, JeOn, BeSt,			
COM4.5	Investigation and maintenance of communication and information tools (including the further shaping and promotion of framateam)	DO, CSS, PM			

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
DaDe,	Daan Degrauwe,	RMI Belgium	3
DeHa, DaDe,	Denis Haumont, Daan Degrauwe,	RMI Belgium/D	11
MaTu,	Martina Tudor,	DHMZ Croatia	0.5
ErCo, JuGr, PhMa, JeCh, FaVo, SeRi,	Erwan Cossevin, Judicël Grasset, Philippe Marguinaud, Jérémy Chesnel, Fabrice Voitus, Sebastien Riette,	Météo-France	20.5
JuGr, NiPe, LoMa,	Judicël Grasset, Nicolas Penigaud, Loïc Maurin,	Météo-France/D	10.5

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 is to prepare and carry out the porting of the ACCORD codes on accelerators such as GPUs. By end-of 2025, it is foreseeen that most of the prognostic computations (i.e. the computations to get to the end of the forecast) for the 3 ACCORD CSCs will be refactored and ported to GPUs. From 2026 onward, the focus of the refactoring (CRA1) and porting (CRA2) will therefore shift to diagnostic computations.

A different strategy to develop an NWP model that is portable 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 are investigated in DY2, the performance and portability of this approach are evaluated in this work package (CRA3).

With substantial parts of the ACCORD model already ported to accelerators, it becomes more and more important to consolidate this work and ensure functionality in new code releases. To this end, building and testing on a variety of hardware platforms, including GPU-powered ones, should become part of the common ACCORD work practice. An extension of the regular testing platform of ACCORD, Davai, in this directions will be investigated.

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)**
CRA1	**Prepare ACCORD codes for porting to GPUs.** 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 overall 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. An important constraint during this refactoring is that the vectorization and the performance on CPU-only machines should not be affected in a negative way.	MaTu, JuGr, PhMa, NiPe, SeRi,	t-code	IAL	
CRA1.1	**Further 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.	JuGr,		other repo	
CRA1.2	**Refactoring of the remaining parts of dynamics and physics.** Most of the refactoring of these parts will be finished by end-of-2025. Any remaining pieces (e.g. non-canonical configurations or new contributions) will be addressed here. One part of the model that has not been addressed so far is SURFEX. An evaluation will be made whether it is necessary and possible to refactor SURFEX to enable porting to accelerators.	NiPe, SeRi,		IAL	
CRA1.3	**Refactoring of diagnostic computations** such as DDH, FullPos and IO. This is very much exploratory work, as it is not clear whether the strategy that was used for the physics and the dynamics is also applicable here. The computational patterns in the diagnostic part (e.g. interpolations for FullPos, averaging for DDH) are significantly different from the column-based computations in the physics and the dynamics. Alternative solutions such as diagnostic computations being done on CPU simultaneously with prognostic computations on GPU, or offloading the diagnostic computations to a dedicated set of MPI tasks (concept of a FullPos server) will be considered.			IAL	
CRA2	**Porting of individual pieces of ACCORD codes to GPUs.** Profiling and tuning to enhance performance.	ErCo, PhMa, NiPe,			
CRA2.1	**Development of source-to-source translator tools.** Gridpoint column calculations (mainly physical parameterizations, but also some dynamics) are ported using source-to-source translation scripts. While the existing scripts have been succesfully applied to ARPEGE physics, ALARO physics and non-hydrostatic dynamics, they can be improved in terms of user-friendliness and robustness. The use of the tool developed by ECMWF, Loki, as an alternative to the existing set of perl scrips will be further explored. New translation recipes that might improve portability or performance will be investigated, for instance using OpenMP offloading instead of OpenACC directives, or generating an even finer granularity of the parallel regions.	ErCo,		other repo	
CRA2.2	**Application of source-to-source translator tools.** Porting to GPUs of remaining gridpoint column calculations (physics parameterizations, gridpoint dynamics) using the tools developed in CRA2.1.	ErCo, NiPe,		IAL	

CRA2.3	**Manual porting to GPUs of some parts of the model.** For some parts of the model, porting by means of source-to-source translator scripts is not possible. This seems to be especially the case for the diagnostic parts of the model. Following the analysis and the refactoring done in CRA1.3, a manual porting for some of these parts may be necessary.	NiPe,			
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.	FaVo, LoMa,	report		
CRA4	Introduce ECMWFs **multIO IO server** in the ACCORD configurations.		t-code	IAL	
CRA5	**Consolidation through testing and integration.** The maintenance of GPU-ported parts of the code requires that they are regularly tested, especially in new code releases. To this goal, both the building of GPU-enabled executables and the testing on GPU-powered platforms should become part of the common ACCORD working practice. Regarding the building, the source-to-source translation tools will be included in the build system(s) used in ACCORD, and compilation will be tested with various compilers on various platforms. Regarding the testing, it will be investigated if GPU-enabled runs can become part of the ACCORD testing platform Davaï (COM2.1).	JuGr,	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
FlWe, StSc,	Florian Weidle, Stefan Schneider,	GEOSPHERE Austria	1
PhSc,	Phillip Scheffknecht,	GEOSPHERE Austria/D	1
MaTu,	Martina Tudor,	DHMZ Croatia	0.5
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech	8
SaAn, SaAn, ErBa, ErBa, DiRi,	Salome Antoine, Salome Antoine, Eric Bazile, Eric Bazile, Didier Ricard,	Météo-France	9
LeRo,	Leo Rogel,	Météo-France/D	5
NaMa,	Najlae Marass,	Maroc Meteo	1.5
WdR,	Wim de Rooy,	KNMI Netherlands/D	3
AnSi,	Andre Simon,	SHMU Slovakia	1
PeSm,	Peter Smerkol,	ARSO Slovenia	1.5

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;
- exploring the predictability and data assimilation at very high resolution.

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. These experiments are performed 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 are being 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 (can use the results of the DEODE project)

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,	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)	PhSc, FlWe, RaBr, J	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~~ **LES Data and Modelling** - Provision of LES data for a suite of cases. - Run LES for substantial domains and compare coarse-grained LES fields with HARMONIE-AROME to study, for example, the partitioning of resolved/unresolved fluxes. - Training on running and use of LES (DALES, MESO-NH).	DiRi, WdR, PeSm,	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**). Pseudo 3D turbulence work.	ErBa, LeRo, DiRi,	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) HR case studies for the 3 CSCs, using the DEODE workflow.	FlWe,	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 (This can be achieved through DEODE, is done in Phase 2, will it go on in the phase 3?)		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	SaAn, ErBa,	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	StSc, SaAn, ErBa, N	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**)	SaAn, ErBa,	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** .		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 or higher), 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	9
LuAu, SyMa, ClLa, HaPe, FaVo,	Ludovic Auger, Sylvie Malardel, Claire Laurent, Harold Petithomme, Fabrice Voitus,	Météo-France	11
LuAu, LoMa,	Ludovic Auger, Loïc Maurin,	Météo-France/D	6
NaSz,	Natalia Szopa,	IMGW Poland	4
AlCr,	Alexandra Craciun,	Meteo Romania	1
NiKa,	Nika Kastelec,	ARSO Slovenia/D	3

WP objectives and priorities

The main objectives of this work package are threefold. First, it aims at modernizing the current hydrostatic and non-hydrostatic dynamical core of the ACCORD system. The basic algorithmic choices will remain unchanged—namely, the use of a semi-implicit or iterative centered implicit time scheme, semi-Lagrangian advection, a spectral horizontal representation of prognostic variables, finite-difference or finite-element representations of vertical operators, and a mass-based hybrid pressure vertical coordinate. A key objective of this modernization is to improve stability in forecast domains with steep orography, which currently pose challenges, as the non-hydrostatic kernel tends to be less stable than its hydrostatic counterpart under such conditions. Several innovations are under development to address this issue, including the use of a modified vertical prognostic variable, the introduction of new parameters into the implicit solver, and the formulation of the Euler equations as an incremental extension of the hydrostatic primitive equations, thereby allowing non-hydrostatic effects to be introduced gradually.
Second, this work package focuses on maintaining the current ACCORD dynamical core. This involves cleaning and pruning existing code branches, merging alternative algorithmic options, and extending their applicability across the full kernel, with the aim of supporting all meaningful combinations in a consistent manner.
Finally, attention is given to improving the coupling and nesting procedures for initial and lateral boundary conditions. This includes studying the handling of coupling files, assessing the influence of domain size on the coupling process, evaluating the effect of the width of the relaxation zone, selecting appropriate model top and upper boundary treatments, and optimizing both the horizontal and vertical interpolation methods used in boundary condition generation.

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)
DY1.1	**Testing of new and recently updated dynamics options :** 1) Reformulation of the nonhydrostatic nonlinear model using new definitions for the vertical motion variable "NVDVAR=5, LBIGW=T" 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) LGWFRIC : 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) SIPRA : 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) LSI_UPDATE_FULL, LSI_UPDATE_CHEAP : These options offers the possibility to build the linear model and (associated vertical parameters defined in the structure YDDYN) "on the fly" (at each time-steps, even at each iterations). ⇒ Refine the definition of SI paratemers taking into account the actual value of some relevant variables (as πs, T, $\nabla\varphi$, $\nabla\pi s$,....) in order to improve robustness and stability of the ICI scheme. 6) The newly updated Vertical Finite Element in non-hydrostatic (VFENH) should also be tested, an increase in terms of forecast quality is expected without degrading the stability.	PtSm, FaVo, NaSz, AlCr, NiKa,	documentation, test report		
DY1.2	**Formulation of the Euler equations as the increment of the hydrostatic primitive equations.** This idea was implemented under the key LNHHY with one control parameter. It was shown to improve the stability of the time-marching scheme by slowing down the fast-moving modes. Moreover, the control parameter governing the degree of non-hydrostatism can change the value during the integration of model prognostic equations enabling a smooth transition from hydrostatic dynamics to fully non-hydrostatic Euler equations. Another available feature of the current implementation is the vertical dependency of the control parameter. The underlying idea is to keep non-hydrostatism almost everywhere but to relax to hydrostatic dynamics near the model upper boundary with generally lower vertical resolution. These new features need to be tested at very high resolutions and in the context of initialization from the hydrostatic leading model. These goals are shared with the DE_330 project.		documentation, test report		
DY1.3	**Optimal initialization methods to dampen initial oscillations or spin-up** at very high resolutions or in case of big resolution gap between leading and nested models. The method described in DY 1.2 can be used for smooth transition from a hydrostatic leading model to a non-hydrostatic nested model. In case of uncontrolled growth of numerical noise at the beginning of integration in very high resolutions, the traditional methods as DFI may be applied. This is relevant in the context of the DE_330 project.		documentation, test report		

DY1.4	**Very High resolution configurations :** In the context of very high-resolution modeling, such as the DE_330 project targeting horizontal resolutions of 200 m to 500 m, several aspects require attention. One important task is the adaptation of the vertical level distribution to better suit these fine-scale domains There is here a link with PH8 tasks where the work on 3D turbulence could benefit to the stability of the dynamical core.. At hectometric and sub-kilometric scales, the limitations of current numerical methods become more apparent. Specifically, the spectral approach and optimal truncation, the semi-Lagrangian advection scheme options , and the semi-implicit time-stepping method must be critically assessed, challenging terrain configurations—such as those including the Himalayan plateau or the steep coastal slopes of Greenland, where cold air interacts with sea-level conditions—are valuable test cases to explore the robustness of the dynamical core under extreme conditions. To better understand and address these limitations, more academic 3D test cases should be designed, and increased collaboration across teams is essential to advance both the theoretical understanding and practical implementation of suitable solutions.	PtSm, LuAu, LoMa, NaSz, NiKa,	report		
DY1.5	**Coupling procedure**: The reduction of the coupling file with the frame approach is available, it works well but add complexity to the system. The need to use more coupling data with chemistry or aerosols could make this technique essential. Maintenance and testing of the availability of the code in future cycles is important		documentation, test report		
DY1.6	**Semi-Lagrangian advection:** The semi-lagrangian scheme is an important component that enables the use of long timesteps. Several tasks must be undertaken : a) The test of new interpolation possibilities such as the WENO scheme with quintic interpolations or SWEEP. b) The assessment of the benefits of new conservative options of the interpolators. c) Testing the use of previous information in the research of the origin point.	PtSm, SyMa, ClLa, HaPe, FaVo,	documentation, test report, source code		

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
OlLi, ToBe,	Ole Lindberg, Tommaso Benacchio,	DMI Denmark	3
FaVo,	Fabrice Voitus,	Météo-France	0.5
LoMa,	Loïc Maurin,	Météo-France/D	1

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.
ECMWF is currently developing a new NH gridpoint dynamical core, in a new model framework, called the Portable Model for Multi-Scale Atmospheric Prediction (PMAP), an advancement of the FiniteVolume Module (FVM) originally developed in Fortran., with a conservative advection scheme and using a new library for geometry and data structure (ATLAS). PMAP will be a natural framework for developing this new dynamical core.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
DY2.1	Based on the latest DSL-based version of PMAP, performance testing will be carried out. The AROME physics package has already been almost fully ported into PMAP. Once this task is completed, the focus will shift to evaluating the stability of PMAP in comparison with the ACCORD model, particularly at very high resolutions and over realistic orography. It is worth noting that certain components of PMAP, such as the transport scheme, may be of less relevance to our specific interests.	OlLi, ToBe, FaVo, LoMa,	documentation, test report, source 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
DaDe,	Daan Degrauwe,	RMI Belgium/D	2
LuAu, FaVo,	Ludovic Auger, Fabrice Voitus,	Météo-France	0.75

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 grid-point dynamics is planned. The implicit solver has already been successfully implemented in grid-point space based on a previous cycle. However, it now needs to be re-integrated into a newer cycle, taking into account the refactoring associated with GPU porting. The development of local derivative operators will rely on the ATLAS library and will follow approaches similar to the halo concepts used in our current codebase. The use of specific solvers will be studied.	LuAu, FaVo,	documentation, new source 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
MOAM, IsLa,	Mohand Ouali Ait Meziane, Issam Lagha,	ONM Algeria	3
BoTs,	Boryana Tsenova,	NIMH Bulgaria	1
KaHi,	Kasper Hintz,	DMI Denmark	1
ErGr,	Erik Gregow,	FMI Finland	1
ViPo, AlDe, MaMa,	Vivien Pourret, Alan Demortier, Marc Mandement,	Météo-France	21.5
AnKV, PeEl,	Aniko Kardos-Varkonyi, Peter Elek,	HungaroMet Hungary	7
SdH, MiKo,	Siebren de Haan, Michal Koutek,	KNMI Netherlands	2
MaMo,	Maria Monteiro,	IPMA Portugal	0.5
MiPa,	Miguel Pardal,	IPMA Portugal/D	0.5
MaDi,	Maria Diez,	AEMET Spain	1.5
MaRi, JoFa,	Martin Ridal, José Faúndez,	SMHI Sweden	4
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	4

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

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)
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.	MaDi, 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.	MOAM, IsLa, BoTs, AnKV, MiPa, MaMo, 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, ErGr, ViPo, AlDe,	T-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, AnKV, PeEl, SdH, MiKo, MiPa, MaMo, MaDi, MaRi, JoFa,	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,	T-codes and scientific note		

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
FlMe,	Florian Meier,	GEOSPHERE Austria	3
IdDe, RiRo, AlSa,	Idir Dehmous, Ricardo Rondinel, Albin Sabu,	RMI Belgium	5.75
AnBu, AlTr,	Antonín Bučánek, Alena Trojáková,	CHMI Czech	3.5
MaDa,	Mats Dahlbom,	DMI Denmark	1
MaMa, PaMo, DoRa, ClAu,	Maud Martet, Patrick Moll, Dominique Raspaud, Clotilde Augros,	Météo-France	23
LaMa, HeKo,	Laura Magyar, Helga Kollathne Toth,	HungaroMet Hungary	7
FaHd,	FatimaZahra Hdidou,	Maroc Meteo	1.5
SdH, SdH, MiKo,	Siebren de Haan, Siebren de Haan, Michal Koutek,	KNMI Netherlands	4
MiNe, MPtc,	Michal Nestiak, Martin Petrovic,	SHMU Slovakia	5.5
BeSt, PeSm,	Benedikt Strajnar, Peter Smerkol,	ARSO Slovenia	3
JaSa, NewcomerAEMET2,	Jana Sanchez, Jose M Perez de Gracia,	AEMET Spain	4
MaRi, GuHa,	Martin Ridal, Gunther Haase,	SMHI Sweden	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 in 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, IdDe, RiRo, AnBu, AlTr, MaDa, MaMa, LaMa, 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.	AlSa, PaMo, DoRa, HeKo, FaHd, SdH, MiNe, JaSa, NewcomerAEMET2,	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.	SdH,	T-codes and scientific note		
DA2.4	**Lidar observations:** Investigate possibilities to assimilate lidar observation. Contribute to discussion on data standardisation within EUMETNET.		T-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.	FlMe, MaMa, ClAu, BeSt,	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
ChBo,	Chahrazed Bouzerma,	ONM Algeria	3
AdNe, FlMe,	Adhithiyan Neduncheran, Florian Meier,	GEOSPHERE Austria	11
MiTs, MeDi, HaSe, BoTs,	Milen Tsankov, Metodi Dinev, Hajar Serrhini, Boryana Tsenova,	NIMH Bulgaria	10
SuPa,	Suzana Panežić,	DHMZ Croatia	5
AlTr, JaSe,	Alena Trojáková, Jáchym Ševčík,	CHMI Czech	6
MaDa, MaDa, MaDa,	Mats Dahlbom, Mats Dahlbom, Mats Dahlbom,	DMI Denmark	2.5
AlVa,	Aleksei Vashchenko,	ESTEA Estonia	1
ReEr, DaSch,	Reima Eresmaa, David Schönach,	FMI Finland	6.5
SiAl, OlAu, OlAu, ThBu, NeCo, ThCa, ThCa, HéDu, NaFo, ChPa, ViPo, ZiSa,	Simon Alix, Olivier Audouin, Olivier Audouin, Thomas Buey, En Cous De Recrutement, Thomas Carrel-Billiard, Thomas Carrel-Billiard, Hélène Dumas, Nadia Fourrie, Christophe Payan, Vivien Pourret, Zied Sassi,	Météo-France	60.5
ZaSa, FaHd,	Zahra Sahlaoui, FatimaZahra Hdidou,	Maroc Meteo	3
IsMo, IsMo, IsMo, ErDe, MiKo,	Isabel Monteiro, Isabel Monteiro, Isabel Monteiro, Erik Dedding, Michal Koutek,	KNMI Netherlands	5.5
BeSt,	Benedikt Strajnar,	ARSO Slovenia	1.5
JaSa, MaDi,	Jana Sanchez, Maria Diez,	AEMET Spain	3
RoSc, NiHa, BeRy, SwMa,	Ronald Scheirer, Nina Håkansson, Bengt Rydberg, Swapan Mallick,	SMHI Sweden	6.5
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	2

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 heritage (e.g. on board NOAA-21 and FY-3E) and new (prgressively available) instruments (MTG imager and sounder)
(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.	ChBo, MiTs, MeDi, HaSe, BoTs, AlTr, MaDa, ReEr, DaSch, OlAu, ThBu, NeCo, ThCa, HéDu, NaFo, ZaSa, IsMo, JaSa, MaDi, 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, SuPa, JaSe, AlVa, ReEr, OlAu, ThCa, HéDu, NaFo, IsMo, BeSt, RoSc, SwMa,	T-codes and scientific note		
DA3.3	**New and 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 / IASI-NG (Transformed Retrievals L2).	MaDa, ReEr, DaSch, OlAu, ThCa, HéDu, NaFo, MaMa, ZiSa, FaHd, IsMo, ErDe, MaDi, NiHa, BeRy, SwMa,	T-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.	SiAl, HéDu, MiKo,	T-codes and 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.	ChPa,	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.	DaSch, ViPo,	T-codes and scientific note		
DA3.7	**GNSS Radio-occulation data (GNSS-RO):** Assist the implementation of GNSS-RO products (meteorological and external data providers).	MaDa,	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
ChBo,	Chahrazed Bouzerma,	ONM Algeria	1
AlTr,	Alena Trojáková,	CHMI Czech	2
HeKo,	Helga Kollathne Toth,	HungaroMet Hungary	0.5
EoWh, RóDa,	Eoin Whelan, Rónán Darcy,	MET Eireann	1.75
ZaSa,	Zahra Sahlaoui,	Maroc Meteo	1.5
VaCo, MaMo,	Vanda Costa, Maria Monteiro,	IPMA Portugal	0.75
MiNe, MiNe,	Michal Nestiak, Michal Nestiak,	SHMU Slovakia	3
MaDi,	Maria Diez,	AEMET Spain	0.5
MaRi,	Martin Ridal,	SMHI Sweden	1
YeCe, ZeÜn, MeSe,	Yelis Cengiz, Zeynep Feriha Ünal, Meral Sezer,	MGM Türkiye	6

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	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.	ChBo, AlTr, EoWh, MaRi,	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.	HeKo, RóDa, ZaSa, VaCo, MaMo, MaDi,	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.	MiNe,	T-Codes and non-T-codes		
DA4.4	**Coordination:** Communication and coordination of transversal questions (e.g. transition to WIS2, development of Bator, ObsConvert, and b2o)	MaMo, YeCe, ZeÜn,			
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.	MaMa, MiNe, YeCe, ZeÜn, MeSe,	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	0.5
AlDe, IdDe,	Alex Deckmyn, Idir Dehmous,	RMI Belgium	1.5
AnBu,	Antonín Bučánek,	CHMI Czech	3
ErGr,	Erik Gregow,	FMI Finland	0.5
EtAr, LoBe, MaDe, VaVo,	Etienne Arbogast, Loïk Berre, Mayeul Destouches, Valerie Vogt,	Météo-France	10
AnKV,	Aniko Kardos-Varkonyi,	HungaroMet Hungary	1
EoWh,	Eoin Whelan,	MET Eireann	0.25
IsMo, IsMo, ErDe, CrRo, CrRo, CrRo,	Isabel Monteiro, Isabel Monteiro, Erik Dedding, Chris Romick, Chris Romick, Chris Romick,	KNMI Netherlands	7
OlVi, BeMe,	Ole Vignes, Benjamin Menetrier,	MET Norway	1.5
MaMo,	Maria Monteiro,	IPMA Portugal	0.25
MiPa,	Miguel Pardal,	IPMA Portugal/D	0.25
MaIm,	Martin Imrisek,	SHMU Slovakia	2
JaSa, CaGe, PaEs,	Jana Sanchez, Carlos Geijo, Pau Escriba,	AEMET Spain	6
MaRi, JoFa, JeBo,	Martin Ridal, José Faúndez, Jelena Bojarova,	SMHI Sweden	4.5
WaKh, HaDh,	Wafa Khalfaoui, Hajer Dhouioui,	INM Tunisia	3
YeCe, ZeÜn,	Yelis Cengiz, Zeynep Feriha Ünal,	MGM Türkiye	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 Objected Oriented 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	Code contrib to repository (About code deliverables (if any))	Expected delivery (MM/YY)
DA5.1	**Develop and consolidate full assimilation cycles using 3D-Var OOPS binaries** in the DAVAÏ (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.	AlDe, IdDe, AnBu, EtAr, LoBe, VaVo, MiPa, CaGe, YeCe, ZeÜn,	T-codes and scientific note		
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, MaDe, VaVo, CrRo, PaEs,	T-codes and scientific note		
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). Recoding of the spectral B in C++ for both calibration and application, to optimize computational cost, increase robustness and to extend the spectral B capabilities when using OOPS. Regular code cycle updates.	EtAr, LoBe, MaDe, VaVo,	T-codes and scientific note		
DA5.4	**Develop OOPS version of LAM 4D-Var** Make use of the Harmonie scripting system in CY49T2h. Parallel runs in full-resolution and all-observation assimilated mode, to verify the equivalence of 4DVAR in OOPS and MASTERODB. Other areas of development: Use the IFS simplified physics, ensemble information, control of LBC and model errors, AI/ML to improve different components of the 4DVAR (descrption of physics, error-of-the-day, model errors and host model information). Inccorporate all-sky satellite MW functionality in OOPS 4D-Var framework (see 3.2). Adoptions towards nowcasting (DA7), such as exploitation of overlapping windows, convergence at high resolution, use of high-density observations, and continous DA.	IsMo, CrRo, JaSa, PaEs, JoFa, JeBo,	T-codes and scientific note		

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, see aso SY1.3). Explore impact of number of iterations in minimisation, trajectory truncations and increment resolution. Experimentation of weakly coupled surface/upper-air DA in 4D-Var outer loops (see also coupled DA activities in DA6).	EoWh, IsMo, ErDe, CrRo, JaSa, PaEs, MaRi,	T-codes and non T-codes, 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, introduction of OOPS, 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, AnBu, AnKV, MaMo, MaIm, WaKh, HaDh,	T-codes and non T-codes, 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.	AnBu, ErGr, 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)

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FlMe,	Florian Meier,	GEOSPHERE Austria	3
IdDe,	Idir Dehmous,	RMI Belgium	1
EmAl,	Emy Alerskans,	DMI Denmark	1.5
DaSch,	David Schönach,	FMI Finland	0.5
GaAr, ThMo, EtAr, LoBe, PiBr, NiGi, ArPu, VaVo,	Gabriel Arnould, Thibaut Montmerle, Etienne Arbogast, Loïk Berre, Pierre Brousseau, Nicole Girardot, Argan Purcell, Valerie Vogt,	Météo-France	31.5
GJMa,	Gert-Jan van Marseille,	KNMI Netherlands	2
BeMe,	Benjamin Menetrier,	MET Norway	4.5
BeSt,	Benedikt Strajnar,	ARSO Slovenia	3
CaGe, PaEs,	Carlos Geijo, Pau Escriba,	AEMET Spain	4.5
JoFa, JeBo,	José Faúndez, Jelena Bojarova,	SMHI Sweden	3.5

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	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, IdDe, EmAl, GaAr, ThMo, EtAr, LoBe, PiBr, VaVo, BeMe, BeSt, CaGe, PaEs, JoFa, JeBo,	T-codes and non T-codes, scientific note		
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.	EtAr, LoBe, PiBr, VaVo,	T-codes, scientific note		
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, VaVo, GJMa,	T-codes and scientific note		
DA6.4	**EnVar with other geophysical fields in OOPS:** surface 2DEnVar; towards coupled ocean/atmosphere/land EnVar.	EtAr, LoBe, PiBr, ArPu, VaVo,	T-codes and scientific note		
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).	DaSch,	T-codes and scientific note		
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.		T-codes and scientific note		
DA6.7	**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		T-codes and scientific note		
DA6.8	**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.		scientific note		
DA6.9	**Generation of ensemble-based co-variances by the GI (Gaussian Integrals).** Following the 3DVar co-variance model, GI suggests extensions which can incorporate a considerable amount of flow-dependency and at the same time make it computationally feasible.	CaGe,	T-codes and scientific note		

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
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ClPe,	Claus Petersen,	DMI Denmark	0.5
DaSch, ErGr,	David Schönach, Erik Gregow,	FMI Finland	1
MaDi, CaGe, NewcomerAEMET2,	Maria Diez, Carlos Geijo, Jose M Perez de Gracia,	AEMET Spain	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	**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. 4) Explore aplication of Variational constraint.	IdDe, CaGe, NewcomerAEMET2,	T-codes and scientific note		
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.		T-codes and scientific note		
DA7.3	**Initialization of meteorological fields with observed datasets:** 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 (FA): use in the context of data assimilation for NWC. Consider HDF5 format usage in Field Alignment context; 3) Nudging (LHN, back and forth technique);	CaGe,	T-codes and scientific note		
DA 7.4	**Towards real-time data assimilation:** on-demand DA, new coupling strategies (LBC "on the fly"), sub-hourly updates, including the experimentation with suitable observations (either real or synthetic).	DaSch, MaDi, CaGe,	T-codes and scientific note		

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
IsLa,	Issam Lagha,	ONM Algeria	1
IdDe,	Idir Dehmous,	RMI Belgium	2
KaTø,	Kasper Tølløse,	DMI Denmark	0.5
AhMe,	Ahto Mets,	ESTEA Estonia	2
DaSch, ErGr,	David Schönach, Erik Gregow,	FMI Finland	1.5
DoRa,	Dominique Raspaud,	Météo-France	0.5
DaLa,	David Lancz,	HungaroMet Hungary	1
EoWh,	Eoin Whelan,	MET Eireann	0.75
FaHd,	FatimaZahra Hdidou,	Maroc Meteo	1.5
GJMa,	Gert-Jan van Marseille,	KNMI Netherlands	3
MaSz,	Małgorzata Szczęch-Gajewska,	IMGW Poland	5
MiNe,	Michal Nestiak,	SHMU Slovakia	1
MeEs,	Mehdi Eshagh,	SMHI Sweden	1.5
WaKh, HaDh,	Wafa Khalfaoui, Hajer Dhouioui,	INM Tunisia	1.5

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

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)
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	IsLa, IdDe, KaTø, AhMe, DaSch, DoRa, EoWh, FaHd, GJMa, MaSz, MeEs, WaKh, HaDh,	T-codes and non T-codes, scientific note		
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.***	ErGr, DaLa, MiNe,	T-codes, 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
MiVa, DvdB,	Michiel Vanginderachter, Dieter Van Den Bleeken,	RMI Belgium	1.25
KaHi, KaHi, MaSc, SiCh,	Kasper Hintz, Kasper Hintz, Mathias Schreiner, Simon Christiansen,	DMI Denmark	2.75
SoOh,	Soma Olah,	HungaroMet Hungary	2
BaAl,	Badreddine Alaoui,	Maroc Meteo	1.5
AlAb,	Alice Abramovicz,	KNMI Netherlands	3
MaPu,	Matjaž Puh,	ARSO Slovenia	3
DaYa, NNse, RoSc, JeBo, SwMa, ToLa,	Daniel Yazgi, Newcommer_SMHI1, Ronald Scheirer, Jelena Bojarova, Swapan Mallick, Tomas Landelius,	SMHI Sweden	10

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

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): 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	JeBo, ToLa,	Scientific note		
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	KaHi,	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,	T-codes and non T-codes, 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, 4) emulation of VarBC	AlAb, DaYa, NNse, RoSc, SwMa,	T-codes and non T-codes, 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.		T-codes and non T-codes, scientific note		
DA9.6	**Data driven forecasting models and 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, DvdB, KaHi, MaSc, SiCh, SoOh, BaAl, MaPu,	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		Scientific note		

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
MaHr,	Mario Hrastinski,	DHMZ Croatia	1.5
PtSm, RaBr, JaMa,	Petra Smolíková, Radmila Brožková, Ján Mašek,	CHMI Czech	2.25
HaSc,	Hauke Schulz,	DMI Denmark	1
FaVo, LoLu, DiRi, SeRi,	Fabrice Voitus, Louis Lutun, Didier Ricard, Sebastien Riette,	Météo-France	16
LeRo,	Leo Rogel,	Météo-France/D	5
WdR, NaTh,	Wim de Rooy, Natalie Theeuwes,	KNMI Netherlands	5
MaKä,	Marvin Kähnert,	MET Norway	1
PeSm,	Peter Smerkol,	ARSO Slovenia	3
JJGA,	Juan Jesus Gonzalez Aleman,	AEMET Spain	0.75
MeSh, AbMe,	Metodija Shapkalijevski, Abhilash Menon,	SMHI Sweden	13

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 an addaptation of the scale-aware mass flux for shallow convection. Note that a scale-aware convection scheme is already 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).

AROME: Continuation of the developments towards a 3D-turbulence scheme (both for psudo and full 3D). A specific fouc will be on the proper treatment of the tereain slops at the surface-atmosphere interface and thus accounting for their effects in the surfex fluxes.

HARMONIE-AROME: From a UWC perspective the key priorities in 2026 are to complete the work/analysis on the missing precipitation from shallow convection and to alleviate issues with cloud rolls, to thoroughly evaluate the wind-farm parametrization and to continue to work on/test scale aware turbulence.

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

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
PH1.1	**The stability-dependency and moist aspects of the TOUCANS scheme** - Revision of the PBL height assessment method and the computation of the scheme's stability parameter to improve the turbulent mixing and decrease the random error of near-surface parameters. - Addressing the shallow convection cloudiness diagnostics and representation of entrainment processes.	MaHr, RaBr,	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, PeSm,	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) - take into account the terrain slope in the surface fluxes	PtSm, FaVo, LeRo, LoLu, DiRi, MeSh, AbMe,	doc, t-code		

PH1.3.2	**3D turbulence: towards full 3D** - Integrating Goger et al. (2018, 2019) developments with the 1D+2D turbulence scheme in TOUCANS, unifying the horizontal turbulence length scale treatment, and testing the adaptation across resolutions. - 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. - take into account the terrain slope in the surface fluxes	LeRo, LoLu, DiRi,	doc, t-code		
PH1.4	**Sensitivity of scale-aware convection & turbulence** - Continue the work on scale-aware shallow convection: test a larger suite of cases and make more quantitative analyses, including cases such as open-cell convection which previously had too little precipitation; explore further options including optimal combinations with microphysics (PH3) and NRT aerosols (PH6) settings, with an emphasis also on improving the cloud cover and alleviation of cloud rolls etc. (Cross ref: MQA2.1 and MQA3.2) - Use of DDH (output) in the analysis and improving of the schemes (e. g. cloud rolls issue) - Scale-aware turbulence length scale assessment - Set up systematic case-based investigations using advanced observational platforms (e.g. the Cloudnet portal) for model validation and sensitivity testing; link to PH4 and MQA - Study of meso-scale organisation in HARMONIE-AROME within the EUREC4A(MIP) project (link to PH3) - boundary perturbations in nested HR-domain simulations	HaSc, DiRi, SeRi, WdR, NaTh, MaKä, JJGA, MeSh,	doc, papers, t-code		
PH1.5	**Wind Farm Parameterization** Evaluate the scheme and case studies; gather the revelant metadata across domains	MeSh,	doc, papers, t-code		
PH1.6			doc, papers, t-code		

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	3
KrNi, OlLi,	Kristian Pagh Nielsen, Ole Lindberg,	DMI Denmark	3
YvBo, SoSc,	Yves Bouteloup, Sophia Schaefer,	Météo-France	5.5
GNPe,	Guðrún Nína Petersen,	IMO Iceland	1
EmGl,	Emily Gleeson,	MET Eireann	3
DaMa,	Daniel Martin,	AEMET Spain	2
KIIv, SaAn,	Karl-Ivar Ivarsson, Sandra Andersson,	SMHI Sweden	3

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: The largest priorities for UWC are to validate the clear-sky SW radiation and to tune the backgrounds accordingly, to externalise calculations from the radiation scheme, to invest in knowledge transfer and familiarisation with the available schemes, to thoroughly validate radiation overall (linked with PH3 and PH6), to complete the work on creating a coarser grid for the radiation calculations.

ALARO: Interfacing and testing of single precision version in 3D model (if not finished in 2025), 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. The interfacing of ACRANEB2 radiation scheme with near real time aerosols is accomplished, plus externalization of cloud effective radii within workpackage PH6. There is currently no idea how to accommodate 3D effects in ACRANEB2. Plugging of ecRad in APL_ALARO is also considered.

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

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	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
PH2.3	**Externalise the effective radius computation and also the CDNC calculation and evaluate the options available in the calculations** - Externalise the effective radius calculations from inside the radiation schemes; develop, recode and test within MUSC cy49. This is connected to PH6. Also externalise the CDNC profile calculations. Evaluate the options. Cross ref: MQA3.2 - A consistent use of particle properties in microphysics-cloud-radiation schemes: Import the effective sizes of cloud ice, cloud liquid, graupel, snow and rain particles from microphysics to the radiation schemes.	EmGl, DaMa,			
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.				
PH2.5	**Evaluation of radiation schemes and aerosol options (Cross ref: MQA3. 2)** - Evaluation of clear-sky radiation using ecRad & old IFS and CAMS aerosols (climate and NRT) - tune background aerosols. 3 CSCs working together on this (link to PH6). - Evaluation and comparison of radiation for clear, liquid, ice and mixed-phase cloud conditions - evaluate using ecRad, Old IFS and all aerosol options. - Evaluation of the cloud scheme when CAMS aerosols are employed (tie in with PH3 and PH6). - Assess the performance of ecRad in 1- and 3D experiments compared to the default (old) IFS scheme. Make a thorough validation of its performance.	KrNi, OlLi, GNPe, EmGl, DaMa, KIIv, SaAn,			
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)				
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.).	YvBo, SoSc, EmGl,			
~~PH2.10~~	~~*note: PH2.10 deleted*~~				

PH2.11	**3D effects of radiation** Continue the development of the coarser grid for radiation based on the IFS model using 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, WaCh,	Walid Chikhi, Walid Chikhi,	ONM Algeria	1
KwVW, DeMa,	Kwinten Van Weverberg, Debasish Mahapatra,	RMI Belgium	1.5
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
DaNe,	David Němec,	CHMI Czech	10
KaKe,	Katarina Keerd,	ESTEA Estonia	1
PaMa,	Panu Maalampi,	FMI Finland	1
SaAn, ErBa, MaMa, SeRi, ClSt, BeVi,	Salome Antoine, Eric Bazile, Marie Mazoyer, Sebastien Riette, Clément Strauss, Benoit Vie,	Météo-France	25.5
EmGl,	Emily Gleeson,	MET Eireann	3
WdR,	Wim de Rooy,	KNMI Netherlands	2
BjEn,	Bjorg Jenny Engdahl,	MET Norway	4
DaMa,	Daniel Martin,	AEMET Spain	1
KIIv,	Karl-Ivar Ivarsson,	SMHI Sweden	1
HaDh, RaBR,	Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	1.5

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).

AROME: LIMA is available in cy49t2. Focus will be on a thorough testing of LIMA in AROME and HARMONIE (?) including: i) comparison/evaluation of the ICE3 and LIMA schemes, ii) cloud-microphysics parameterization in cold climate, iii) parameter-sensitivity study for improving the forecast of fog (and the impact of LIMA in relation to fog), iv) SOFOG3D model intercomparison studies.

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. Two moment microphysics is being developed, the work on the liquid phase is very far advanced while the ice phase is under developemnt.

HARMONIE-AROME: The highest physics priority for UWC in 2026 will be to improve the forecasting of clouds including extensive work on alleviating the following known issues: the overestimation of condensate in frontal clouds, alleviating the issues with stratocumulus clouds, the lack of cloud under high pressure systems and the forecasting of fog and low visibility. This work will involve tasks listen under PH2 and PH6 also. The work will involve an extensive validation of the ICE3 scheme and the LOCND2 option for different microphysics regimes (liquid, ice, mixed phase) with a focus on improving the cloud condensate, hydrometeors, cloud cover/base/depth. Comparisons to observations from supersites, the CloudNet network, satellite data, RADAR retrievals and other data sources will be done. MUSC cases will be used to aid understanding of the microphysical processes and the sensitivity of the microphysics to various settings will be investigated.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	Code contrib to repository	Expected delivery (MM/YY)
PH3.2	**ALARO microphysics (APLMPHYS)** - Improvement of processes and vertical geometry, study of their feedback - Analysis of aerosol introduction. - Two moment microphysics for liquid and solid phases	KwVW, DeMa, MaTu, DaNe,			
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).	WaCh, SaAn, MaMa, ClSt, BeVi, BjEn,			
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) -The overall focus for HARMONIE-AROME is on evaluating ICE3 using 3D experiments and MUSC case studies (e.g. MPACE, SoFOG3D) and making comparisons to observations such as those in CloudNet, Radar profiles, satellite data and measurement campaigns. Evaluation of cloud cover, cloud liquid and ice, hydrometeors and precipitation. (link with PH6, MQA3. 2). - Make a detailed assessment of ICE3 in relation to the impact of cloud droplet number concentration (prescribed or computed from CAMS) and the shape parameters in the cloud droplet size distribution for cases such as fog and other cloud formations, convection and precipitation. Cross ref: MQA3.2. - Further testing in of rain_ice vs rain_ice old in HARMONIE-AROME. - A thorough evaluation of LOCND2 using non-standard observations. Cross ref: MQA3.2. - Evaluation of single precision versus double precision for microphysical processes.	WaCh, PaMa, SaAn, ClSt, BeVi, EmGl, KIIv, HaDh, RaBR,			

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 campaign. - Testing and validation of the implemented ICE-T in CY49 for a range of case studies (under rain_ice and rain_ice_old) - Implementing ICE-T elements in LIMA	ErBa, MaMa,			
PH3.7	**Explore the behaviour of precipitation at the lateral boundaries (nesting problems)**	KaKe			
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, BeVi,			
PH3.12	**Study the influence of vertical resolution on decoupling in SBL and fog formation** Link to PH7.6	BeVi,			
PH3.13	**Study the impact of (LIMA) cloud microphysics in relation to fog**	SaAn, MaMa,			
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.	MaMa,			
PH3.15	**Forecast of hail in ICE3/ICE4** Further improve ICE3/ICE4 especially with respect to forecast of hail.	EmGl,			
PH3.16	**Microphysics Intercomparison Exercises** e.g. using MPACE case, and other MUSC cases (see PH4 package). Also extend to 3D. Focus on CSC intercomparison. A focus on processes in microphysics. Cross ref: MQA3.2.				
PH3.18	**New developments in ICE3** Use of Nc for autoconversion, pdf harmonisation	MaMa, DaMa,			
PH3.19	**Development of the 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 (available as switch in cy49) which removes two tuning constants. Hereafter, long term verification (including EUREC4A) is necessary before operational implementation. - Make the cloud scheme scale-aware. Most of the statistical cloud scheme is already scale-aware as long as turbulence and convection are scale-aware but this is not the case for the extra variance term (VSIGQSAT) which should be made scale-aware in some simplified way. - Cloudiness parametrisation utilizes prognostic condensates and water vapour - Cloud scheme, shallow convection cloudiness. See PH2.4 also.	SeRi, WdR,			

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	0.25
ErBa, YvBo,	Eric Bazile, Yves Bouteloup,	Météo-France	1.5
EmGl,	Emily Gleeson,	MET Eireann	1

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 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 work needs to be done for ALARO and SURFEX. In order to increase the number of available "ideal" cases, David's approach will be tested on all three CSC's to have a diversity of meteorological situation to evaluate, compare all the parametrizations available across the CSCs. 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

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
PH4.1	**Establish, maintain and upgrade “common MUSC” system**	ErBa, YvBo,			
PH4.2	**Create and add (idealized) test cases (using David Nemec's method, see also PH3.16)**	YvBo, EmGl,			
PH4.3	**MUSC training and working days**	EmGl,			
PH4.4	**MUSC used for testing "the possible refactoring" of aplpar (resulting in apl_alaro and apl_arpege) and apl_arome**	YvBo,			
PH4.5	**Set up for daily MUSC runs (a few supersites, using DDH also)**	EmGl,			
PH4.6	**MUSC cases in DAVAI with and without SURFEX.**	EmGl,			

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
BoTs, MeDi,	Boryana Tsenova, Metodi Dinev,	NIMH Bulgaria	4
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
PaMa,	Panu Maalampi,	FMI Finland	1.5
SaAr, ErBa, PiCr, InEt, JePi,	Sara Arriolabengoa, Eric Bazile, Pierre Crispel, Ingrid Etchevers, Jean-Marcel Piriou,	Météo-France	16
AnSi,	Andre Simon,	SHMU Slovakia	3

WP objectives and priorities

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

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

As an outcome of the 2021 inquiry (aka PH5-questionnaire), the model output fields have been grouped into four categories for which we intend, at ACCORD level, to build more synergy across teams. Various needs for postprocessing fields (for traffic, energy or tourist/sport sectors) can be assigned to a task depending on the category of the required output. The intention is to organize dedicated meetings per category, so that the teams involved in each can exchange about their plans, and transversal collaboration per thematic can be encouraged. Another aim of the WP PH5 is to coordinate the work done on the implementation of the selected parameters into the common code for all three CSCs, and to implement, tune and validate these parameters. The new postprocessing parameters need to be validated (related to MQA) and for that new data types might be needed (DA3-DA4).

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

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
PH5.1	**Organisation of PH5 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, JePi,	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, JePi,	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		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.		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	BoTs, MeDi, PaMa, 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	BoTs, MeDi, InEt, JePi,	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	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 ?)	BoTs, MeDi, 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	7
MaTu,	Martina Tudor,	DHMZ Croatia	0.25
JaMa,	Ján Mašek,	CHMI Czech	0.75
BeVi, SoSc,	Benoit Vie, Sophia Schaefer,	Météo-France	5
EmGl,	Emily Gleeson,	MET Eireann	2.5
PiSe,	Piotr Sekuła,	IMGW Poland	3
DaMa,	Daniel Martin,	AEMET Spain	2
KIIv,	Karl-Ivar Ivarsson,	SMHI Sweden	1

WP objectives and priorities

ONE LINE SUMMARY: Build and evaluate 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.

HARMONIE-AROME/UWC: Our priorities are included in the sub-tasks under each heading, with the biggest priority being the validation of the available options and the sensitity of the forecasts to a suite of radiation and microphysics settings, with the over-arching aim of improving the forecasting of clouds in HARMONIE-AROME, such as improving the overestimation of condensate in frontal clouds, alleviating the issues with stratocumulus clouds, the lack of cloud under high pressure systems and the forecasting of fog and low visibility.

ALARO: testing of configurations that allow operational usage. Near real time aerosols imply a lot ov data transfer in the coupling files, so other more optimal solutions will be tested. Validation against measured incoming solar radiation (also related to MQA3).

AROME: Our main priority is to have n.r.t. aerosols available for radiation in the next AROME operational chain (cy51). We'll be working on validating the use of n.r.t. aerosols in AROME and their impact on radiation fluxes. We'll start with a clear-sky evaluation, to eliminate the impact of microphysics and check that we're not degrading downward solar fluxes. Then we'll look at dusty situations to assess the impact of n.r.t. aerosols on downward solar fluxes. A second part of the work consists of evaluating the inclusion of n.r.t. aerosols for microphysics. A physical issues still need to be resolved in this respect, before we can envisage an operational implementation in AROME.

The possibility to replace external preprocessing of MMRs/IOPs with the use of netcdf tools from ECRAD will be studied.

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.

Anticipated t-code deliverables within: cy50t1/2
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.

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.** - Maintain the gl method for n.r.t. aerosols. ASCII/binary input from CAMS reanalysis via c9xx climate generation. - Ensure unified handling of climate/nrt input in the forecast model using GFL structures. - Test the 3D CAMS climatology v.s. extrapolation of the 2D climatology in the vertical?	JaMa, BeVi,	t-code		
PH6.2	**AEROSOL USAGE IN CLOUD-PRECIPITATION MICROPHYSICS (connection to PH3)** - Maintain/develop liquid and ice particle derivations from hydrophilic/hydrophobic aerosol particles in ICE3/OCND2/ICE-T microphysics. Freezing of liquid particles, heterogeneous ice nucleation. Size distribution of CCN, droplets.	BeVi, DaMa,	report		
PH6.3	**PREPARATION OF REAL-TIME AEROSOL OPTICAL PROPERTIES FOR THE RADIATION SCHEMES** - Backport the ALARO way of introducing AIOPs from ECMWF netCDF files for IFSRAD25 in cy49Th. - Backport ALARO way of handling (stratospheric) aerosol background concentrations for radiation.	SoSc,	t-code		

PH6.4	**CLOUD-AEROSOL-RADIATION INTERACTIONS (connection to PH2, PH3)** - Externalise the existing calculations of CDNC, CCN and CIN, the effective and equivalent radii of cloud particles from inside of the radiation and cloud microphysics schemes (IFSRAD, ecRad, ICE3/OCND2), develop methods. - Go through the various options in the code to check which have the greatest impact e.g. RADSN, RADGR, cloud overlap.	SoSc, EmGl, DaMa,	t-code		
PH6.5	**VALIDATION AND TESTING (connection to PH2, PH3)** - Evaluation of global clear-sky radiation fluxes (ecRad and CAMS climatological and NRT aerosols) in order to tune the background aerosols consistently for the 3 CSCs. - Ensure availability of extended diagnostic output of radiation and precipitation fluxes, cloud liquid and ice properties. - Testing and validation of the available radiation schemes and aerosols options to decide on viable options for operations (See also PH2.5).	JaMa, SoSc, EmGl, PiSe, KlIv,	report		
PH6.6	**AEROSOL CODE CONSISTENCY BETWEEN CSCs IN CLIMATE GENERATION AND FORECAST MODEL**		Documentation		
PH6.7	**Develop, maintain and evaluate the dust modeling function.** - Replacement of AROME-Dust by a version using the ACCALMIE project's ACLIB library (cy49). Validation and verification for the implementation of this new system. - Testing this new version of the system in pre-operational mode (Algerian colleagues).	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
RaHa,	Rafiq Hamdi,	RMI Belgium	1
MaHr,	Mario Hrastinski,	DHMZ Croatia/D	0.75
JaMa,	Ján Mašek,	CHMI Czech	1
KrNi,	Kristian Pagh Nielsen,	DMI Denmark	1
AdVe, NaTh,	Adithya Vemuri, Natalie Theeuwes,	KNMI Netherlands	6

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** Second set of developments necessary for ALARO with SURFEX is available on top of CY49T2_bf. It should be phased to IAL repository when CY51(?) with SURFEX version 9 is open for surface developments.	RaHa, JaMa,		IAL	
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.	AdVe, 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): - 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		Documentation, a report		
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		Documentation, a report		
PH7.6	**Risk assessment of lowest model level in surface-atmosphere coupling** We see activities where the lowest model level is pushed closer to the ground. However, we currently lack any understanding how this will affect the results in a range of stability regiemes. The purpose is to investigate and quantify the impact of lowering the lowest model level on surface-atmosphere energy exchange. - Adapting the ALARO code to differentiate vertical levels in the turbulence scheme from those in the model dynamics, enabling a safe lowering of the first model level while preserving the surface-layer constant flux approximation and a sufficiently elevated forcing level.	MaHr,		IAL	

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.	KrNi,		IAL	

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

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
PH8.1	**Evaluate the impact of changing the thermodynamics variable for specific parametrisations or diagnostic computations.** The idea would be to build on the proposal by Pascal Marquet. Applications could be on specific diagnostic fields (eg. like the example of the computation of the PBL height), turbulence (changing the Theta variable has a consequence on the equations, in any scheme), impact of having the Lewis number # 1.	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. Allowing turbulence to be coupled from other than the lowest model level so that the lowest model level may be placed very close to the surface but the turbulence is properly coupled.				

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
KnEi,	Kerroumi Nour El Isslam,	ONM Algeria	2
StSc, DaNe,	Stefan Schneider, David Neubauer,	GEOSPHERE Austria	6
AnBu, AlTr,	Antonín Bučánek, Alena Trojáková,	CHMI Czech	5
SoTh,	Søren Borg Thorsen,	DMI Denmark	1
ErGr, MiHa, EkKo,	Erik Gregow, Mikael Hasu, Ekaterina Kourzeneva,	FMI Finland	6.5
CaBi, NaFo, SoMa, ClSo,	Camille Birman, Nadia Fourrie, Sophie Marimbordes, Clément Soufflet,	Météo-France	12.5
HeKo,	Helga Kollathne Toth,	HungaroMet Hungary	6
BeSt, MaLa, MaLa, MaLa,	Benedikt Strajnar, Matjaž Ličar, Matjaž Ličar, Matjaž Ličar,	ARSO Slovenia	9
MeEs, JoFa, RoSc, PaSa,	Mehdi Eshagh, José Faúndez, Ronald Scheirer, Patrick Samuelsson,	SMHI Sweden	9

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, ErGr, MiHa, EkKo, CaBi, SoMa, HeKo, MaLa,			
SU1.1.1	For CANARI and SODA (i) consider fractional covers instead of the land-sea mask (ii) improve using of patches.	EkKo,			
SU1.1.3	Further develop snow analysis and assimilation based on satellite snow extent (e.g. H-SAF, Cryo) in CANARI, Pysurfex or 2D(En)Var. Please state in expected outcome which assimilation method is used and where it is located (e.g. CANARI, SODA, 2D(En)Var ...).	MiHa,			
SU1.1.4	Development of SYNOP-based snow analysis in CANARI or 2D(En) Var. Also improved consitency between variables will be considered. May include spatial analysis of snow and update of SWE. Please specify details in expected outcome.	HeKo,			
SU1.1.5	Continue the development of pySurfex, including TITAN and gridPP and coupling to SODA.	ErGr,			
SU1.1.6	2D-Var and 2D-EnVar evaluation and development in AROME-France	CaBi, SoMa, MaLa,			
SU1.1.8	Examine satellite derived skin temperature using 2D OI in CANARI or 2D(En)Var for AROME-France.	CaBi, MaLa,			
SU1.1.9	Examine the use of amateur weather observations (like Netatmo) in surface assimlation in HARMONIE-AROME, using gridpp				
SU1.1.11	Examination and tuning of CANARI OI T2m and Rh2m analysis.				
SU1.2	Vertical OI (incl. SODA) evaluation and development	KnEi, AnBu, AlTr,			
SU1.2.1	Tuning of OI soil assimilation (i.e. oi_cacsts and corresponing routines).	AnBu, AlTr,			
SU1.2.2	It has been questioned if current assimilation update of TEB road vaiables should be done. Sensisitivy study on the initialization of TEB prognostic variables including a recycling of TEB to reduce the spin-up in high resolution urban simulation.	KnEi,			
SU1.3	SODA EKF evaluation and development	StSc, DaNe, HeKo,			
SU1.3.1	Validation of SEKF surface assimilation for ForceRestore?? with 1 patch with SYNOP observations and operational upgrades				
SU1.3.2	Consider, develop and evaluate SEKF for the combination of diffusion soil, Explicit snow and MEB with 2/3 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,			
SU1.3.5	Develop/assess sEKF/EnKF for TEB, using satellite products, in AROME.	StSc, DaNe,			
SU1.4	SODA EnKF evaluation and development	MaLa, MeEs, RoSc, PaSa,			
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.	MaLa,			
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)	MaLa,			
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.	MaLa,			
SU1.6	Towards coupled data assimilation	BeSt, MaLa, JoFa,			
SU1.6.1	Strategic and practical steps towards a more strongly coupled atmosphere-surface assimilation system. Discussed plans include a combination of the following componenets: 2DEnVar, OOPS, LETKF. See also DA6.4.	BeSt, MaLa, JoFa,			
SU1.7	Development of surface DA tools	SoTh,			
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.				
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 DA9.3.				

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, DaNe,	Daniel Deacu, Stefan Schneider, David Neubauer,	GEOSPHERE Austria	10
DaDe,	Daniel Deacu,	GEOSPHERE Austria/D	3
RaHa, KwVW, DeMa,	Rafiq Hamdi, Kwinten Van Weverberg, Debasish Mahapatra,	RMI Belgium	2.5
MaHr,	Mario Hrastinski,	DHMZ Croatia	1.25
RaBr, JaMa,	Radmila Brožková, Ján Mašek,	CHMI Czech	7
EkKo,	Ekaterina Kourzeneva,	FMI Finland	3
AdNa, BeBo, SoBi, PaLe, MaMi, AnVe, TiNa, VaMa,	Adrien Napoly, Bertrand Bonan, Soline Bielli, Patrick Le Moigne, Marie Minvielle, Antoine Verrelle, Tim Nagel, Valéry Masson,	Météo-France	26
WdR, HdV,	Wim de Rooy, Hans de Vries,	KNMI Netherlands	0.75
PiSe, GaSt,	Piotr Sekuła, Gabriel Stachura,	IMGW Poland	7
SaVi,	Samuel Viana,	AEMET Spain	3
PaSa,	Patrick Samuelsson,	SMHI Sweden	3
OnDo, CeKı, MeSe,	Onur Hakan Doğan , Celaleddin Kızılkaya, Meral Sezer,	MGM Türkiye	5

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: The goal is to undertake steps towards operational implementation of ALARO + SURFEX + to have necessary changes entering t-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)
SU3.1	Test, validate and further improve (namelist combinations and improving physics by code modifications) 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. Develop and apply validation system OSVAS, to use flux and soil observations from ICOS stations.	DaDe, EkKo, AdNa, BeBo, SoBi, PaLe, MaMi, AnVe, WdR, SaVi, PaSa,	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. 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, StSc, DaNe, RaHa, AdNa, BeBo, TiNa, VaMa,	report, configuration		
SU3.7	Assess the performance of different sea flux schemes (CSEA_FLUX) over ACCORD NWP domains. Study the errors in fog prediction over the sea. Link with PH7.		Tests of ECUME vs ECUME6 in HARMONIE-AROME will be repeated, because of a bug found in writing of evaporation flux to atmospheric files (used in last evaluation).		
SU3.9	Preparation and validation of ALARO + SURFEX pre-operational configuration at a kilometric resolution. Testing FLake for treating lakes and eventually also rivers. Link with SU1.	MaHr, RaBr, JaMa, PiSe, GaSt, OnDo, CeKı, MeSe,	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.				
SU3.12	Evaluate prognostic LAI (A-gs) for NWP setups.				
SU3.13	Coupling to hydrological processes (offline SURFEX with TRIP)				

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
KnEi,	Kerroumi Nour El Isslam,	ONM Algeria	1
MaHr,	Mario Hrastinski,	DHMZ Croatia	0.25
AaBo,	Aaron Boone,	Météo-France	1
NaMa,	Najlae Marass,	Maroc Meteo	1.25
MeSh,	Metodija Shapkalijevski,	SMHI Sweden	2

WP objectives and priorities

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

In SURFEX, development of existing, under-developed, or still missing components continue, describing more processes and implementing more methods of diagnostic. During this RWP period, the planned development by NWP team includes: increase in sophistication for the Simple Ice scheme (SICE), improving the model performance over snow/glacier areas, the Multi-Energy Budget (MEB) scheme for open land, additional parametrization of fractional snow and improvement of winter aspects in the urban model TEB, new formulations of vegetation roughness (rough sublayer scheme RSL), exploring the use of 1-D ocean model GOTM. Any new development should be contributed via the SURFEX repository to ensure that contributions become part of new SURFEX releases and that they enter new NWP cycles in a consistent way.

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
SU4.1	Improve representation of glaciers by use of albedo observations.	KnEi,	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.	NaMa,	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,	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.				
SU4.13	Evaluate the orographic parameterisation OROTUR				
SU4.14	Code a common tuning coefficient, independent of ECOCLIMAP version, for ECOFG and ECOSG for tree height tuning.				
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.				
SU4.16	In TEB, adapt and optimize roof temperature modeling to better represent Mediterranean climate conditions in North Africa where roofs in this region are often open and less insulated than in Europe, allowing more direct interaction with the canyon air that should be reflected in TEB configurations.	KnEi,			
SU4.17	Forecast uncertainty estimation for very-high resolution stand-alone SURFEX (100m grid) by emulating ML-based ensemble members				

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	1
RaHa,	Rafiq Hamdi,	RMI Belgium	0.5
MaHr,	Mario Hrastinski,	DHMZ Croatia	0.5
PaMa, EkKo,	Panu Maalampi, Ekaterina Kourzeneva,	FMI Finland	2
RuMa, OlSa,	Rudolf Mård, Olli Saranko,	FMI Finland/D	3
DiTz, JeWu,	Diane Tzanos, Jean Wurtz,	Météo-France	6
BoPa,	Bolli Pálmason,	IMO Iceland	2
NaMa, Hakh, Hakh,	Najlae Marass, Hafsa Khaye, Hafsa Khaye,	Maroc Meteo	7.25
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, Hakh,	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.	DiTz, BoPa,	database, reports, documentation, code		
SU5.3	Tree height data activities. Potentially evaluate new data sets		report, code		
SU5.4	Lake database (GLDB) Participate in GLDB developments and studying the impact.	BoPa,	database, code, reports		
SU5.5	ECOCLIMAP SG activities. Examining and participate in developments. Impact studies are also described in MQA3.	RuMa, DiTz, NaMa, Hakh,	report		
SU5.6	Development of the fine (hectometric) scale Cover map for Europe using ML approach. Link with DEODE.	PaMa, EkKo, OlSa, PaSa,			
SU5.7	Tools (with documentation) for handling of physiography data. Work to increase the efficiency of PGD: optimization and clipping. Link with DEODE.	BoPa,			
SU5.8	Use Open street map as alternative land cover for SURFEX. Should be coordinated with SU5.6	JeWu,			

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
SyMa, MaBo, CiLe, FlNi,	Sylvie Malardel, Marie-Noelle Bouin, Cindy Lebeaupin-Brossier, Fleur Nicolay,	Météo-France	13.125
PaSa,	Patrick Samuelsson,	SMHI Sweden	0.5

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 CSC, 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. Firstly, the coupling of ALARO with a wave model is to be implemented, NEMO can be added afterwards.

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://github.com/Hirlam/HCLIM/wiki/Rolling-Working-Plans

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	About code deliverables (if any): Code contrib to repository	Expected delivery (MM/YY)
SU6.1	Set-up of AROBASE (AROME-based) coupled system	MaBo, CiLe, FlNi, ClSo,			
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	HdV, PaSa,			
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	HdV,			
SU6.4	Further improve AROME/CMO coupling for tropical cyclone prediction	SyMa,			

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, ToJU,	Markus Dabernig, Alexander Kann, Toni Jurlina,	GEOSPHERE Austria	9
ToJU,	Toni Jurlina,	GEOSPHERE Austria/D	1
GeSm, JvdB,	Geert Smet, Joris Van den Bergh,	RMI Belgium	1
IrOd, IvVu,	Iris Odak, Ivan Vujec,	DHMZ Croatia	2.5
ClBr, LaRa,	Clement Brochet, Laure Raynaud,	Météo-France	3
AnBo, MaLa,	Angélique Bonamy, Maxence Lame,	Météo-France/D	9
KaJR,	Katalin Javorne Radnoczi,	HungaroMet Hungary	2.5
BaAl,	Badreddine Alaoui,	Maroc Meteo	2
HaKi,	Harun Kivril,	KNMI Netherlands	2
BoBo, JaRo,	Bogdan Bochenek, Jadwiga Róg,	IMGW Poland	6

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.

Ensemble size remain insufficient to accurately predict high-impact weather events. Generative deep learning approaches are developed to generate additional members from the same distribution and with proper physical consistency.

Across the different calibration methods **the overall goal is to ensure forecast reliability and to improve prediction of high-impact and extreme events.**

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.		Non-t-code		
E6.4	Generation of ensemble members by deep learning approaches (diffusion-based models): (1) evaluation for enriching AROME-EPS for both initial and forecast states ; (2) explore added value of extended initial conditions ensemble for data-driven ensemble regional forecasting.	MaDa, AlKa, ToJU, AnBo, ClBr, MaLa, LaRa, BaAl, BoBo, JaRo,	Trained neural networks, scientific publications		
E6.5	Continue work on machine learning and statistical post-processing methods to calibrate and improve the point or gridded forecasts of high-resolution meteorological output fields. Investigate the applicability of the post-processing methods for other forecast fields.	GeSm, JvdB, IrOd, IvVu, KaJR, BaAl, HaKi, BoBo, JaRo,	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	3.75
HeFe,	Henrik Feddersen,	DMI Denmark	2
LaDe, ArMo, LaRa, FlRo, AlAl, FrBo, GaCo, HuMa, ElSo,	Laurent Descamps, Arnaud Mounier, Laure Raynaud, Flore Roubelat, Alexandre Albert-Aguilar, Francois Bouttier, Gabriel Colas, Hugo Marchal, Elena Sola Cova,	Météo-France	52.5
KaJR, ZsSz,	Katalin Javorne Radnoczi, Zsofia Szalkai,	HungaroMet Hungary	4
MoJi,	Mohamed Jidane,	Maroc Meteo	2
AlCa, JuGo,	Alfons Callado , Juan Gomez Navarro,	AEMET Spain	2

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.

The developments must (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 using AI/ML are increasingly being used to develop user-oriented approaches, and with ensemble sizes that may grow by an order of magnitude using data-driven ensemble models, **the need for probabilistic products is expected to become more urgent in the coming years.**

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
E7.1	Objective identification of convection objects and of severe storms in ensemble outputs, using convolutional neural networks. Development of a deep-learning based clustering of ensemble members to identify a small number of informative scenarii, application to heavy rainfall events.	ArMo, LaRa	Scientific publication, trained neurals networks		
E7.2	Development of Extreme Forecast Index (EFI) and Shift of Tails (SOT) with AROME-EPS and HarmonEPS. Setup operational production.	AlAA, LaRa, AlCa, HeFe	EFI in operations at Météo-France and elsewhere		
E7.3	Development of decision making criteria for renewable energy: power cut outs, wind/solar energy production probabilistic forecast. Clustering methods to extract user-relevant scenarii from ensembles (Contr. MF).	FlRo, ArMo, LaRa, GeSm, JvdB	report, scientific publications		
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.	JvdB	scientific publication(s) /report(s)		
E7.8	Use of AROME and Harmonie-AROME ensemble forecasts for emergency dispersion modelling (nuclear or chemical). Use AROME-EPS in a dispersion modeling chain ; apply clustering algorithms to identify the main scenarii for risk assessment (contrib. MF)	LaDe, LaRa	scientific publications/reports		
E7.9	Development of LAM-EPS EPSgrams (in the framework of Eumetnet/SRNWP-EPS): 1) For precipitation, assessing the likelihood of different types of precipitation, focusing on those for high-impact weather. 2) For visibility, different ranges of visibility relevant for aviation purposes.	JuGm, AlCa			
E7.10	Development in cooperation with operational aviation forecasters of probabilistic forecast products specifically designed for aviation.		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		
E7.12	Continue work on statistical post-processing of EPS data	MaDa	non-t-code		
E7.13	Work on the new ensemble techique CEM (Cascading Ensemble Method)	BoBo, JaRo	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
FlWe, ClWa, NaAw,	Florian Weidle, Clemens Wastl, Nauman Awan,	GEOSPHERE Austria	6
MaTu,	Martina Tudor,	DHMZ Croatia	1
MaFr,	Martin Frølund,	DMI Denmark	0.5
SeSe, OlNu, LaRa, GrRo,	Selvaraj Selvaraj, Olivier Nuissier, Laure Raynaud, Gregory Roux,	Météo-France	16
KaJR, ZsSz,	Katalin Javorne Radnoczi, Zsofia Szalkai,	HungaroMet Hungary	3.5
XiZh,	Xiaohui Zhao,	IMO Iceland/D	0.75
MoJi,	Mohamed Jidane,	Maroc Meteo	2
OlVi,	Ole Vignes,	MET Norway	1
MaKo, JaRo,	Marcin Kolonko, Jadwiga Róg,	IMGW Poland	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. **Developments towards EPS functionality of a common scripting system are particularly welcome.**

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	NaAw, MaFr, SeSe, LaRa, GrRo, XiZh,		IAL	
E8.2	Development of an Arome-based EPS system for other Arome models (Overseas, Morocco). Exploring specific topics for such specific EPS's (perturbation strategies, impact of specific tunings, evaluation on tropical cyclone predictability)	OlNu, MoJi,	non-t-code		
E8.3	Operationalization of C-LAEF system at 1km. Optimization, tuning and maintenance.	FlWe, ClWa,	non-t-code		
E8.4	Optimization and tuning of convection-permitting ensemble system on HPC at HungaroMet	KaJR, ZsSz,	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		non-t-code		
E8.7	Maintenance and evolution of the HarmonEPS system. Porting to new cycles. Introduce system changes to support required developments.	OlVi, UlAn,	non-t-code		
E8.8	Maintenance and regular upgrades of the operational A-LAEF system running at ECMWF HPCF	MaTu, MaKo, JaRo,	non-t-code		
E8.10	Development of an ALARO-based convection-permitting EPS coupled to the regional ensemble A-LAEF, running at SHMU HPC		non-t-code		
E8.11	Development of an hectometric (750m resolution) version of Arome-France EPS, first as a research demonstrator.	SeSe, LaRa, GrRo,			
E8.12	Implementation of SURFEX in ALARO-EPS				
E8.13	Extension of C-LAEF based Ensemble Reanalysis dataset (ARA)	NaAw,			
E8.14	Further development of EPS functionality in the DEODE prototype scripting system Tactus	MaFr, XiZh,			

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	2
GeSm, MiVa,	Geert Smet, Michiel Vanginderachter,	RMI Belgium	0.5
EnKe,	Endi Keresturi,	DHMZ Croatia	1.5
MaFr,	Martin Frølund,	DMI Denmark	1.5
JaKa, PiOl, KaHa,	Janne Kauhanen, Pirkka Ollinaho, Karoliina Hämäläinen,	FMI Finland	8.5
PiOl,	Pirkka Ollinaho,	FMI Finland/D	1
LaDe, OlNu, GrRo,	Laurent Descamps, Olivier Nuissier, Gregory Roux,	Météo-France	5
KaJR, ZsSz,	Katalin Javorne Radnoczi, Zsofia Szalkai,	HungaroMet Hungary	5
XiZh,	Xiaohui Zhao,	IMO Iceland	2
JaFa,	James Fannon,	MET Eireann/D	1
MoJi,	Mohamed Jidane,	Maroc Meteo	2
ArTs,	Aristofanis Tsiringakis,	KNMI Netherlands	6
InFr,	Inger-Lise Frogner,	MET Norway	4
UlAn,	Ulf Andrae,	SMHI Sweden	1

WP objectives and priorities

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

Optimization and preparation for operationalization of parameter perturbations require substantial tuning. One tool that has been applied to this end is the URANIE uncertainty and sensitivity platform. URANIE has been tested both in the HarmonEPS system and in the MUSC 1D-model. With several people now knowledgable about URANIE it is a priority to apply URANIE in the optimization of parameter perturbations.

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
E9.1	Model perturbations for AROME-EPS versions: assess parameter perturbations, SPPT, SPP.	LaDe, OlNu, GrRo, MoJi,	Scientific publications, reports	IAL	
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 in AROME-EPS in Hungary, by making more parameters ready for operations and by adding more parameters to the scheme.	KaJR, ZsSz,	Namelist tunings. New code for new parameters and correlations.	IAL	12/26
E9.5	Improve stochastic parameter perturbations (SPP) in C-LAEF, expansion to dynamics	ClWa,	t-code	IAL	12/26
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,	t-code	IAL	12/26
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.		t-code		
E9.9	Test parameter sensitivity using the URANIE framework.	MiVa, MaFr, XiZh,	Report		12/26
E9.10	SPP (Stochastically perturbed parameterizations) will be further developed and extended in Harmonie. Work will focus on flow dependence and adapting the scheme to higher resolution, as well as setting it up for cy49. If needed, adapt to physics changes.	JaKa, PiOl, KaHa, XiZh, JaFa, ArTs, InFr, UlAn,			

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, FlMe,	Florian Weidle, Florian Meier,	GEOSPHERE Austria	2
VaVo, GrRo,	Valerie Vogt, Gregory Roux,	Météo-France	2

WP objectives and priorities

The objectives are twofold.
1) Develop initial conditions that reflect the uncertainty in the initial conditions and can be used in an EPS. Examples include EDA, LETKF and Brand.
2) Develop ensembles that are suitable for ensemble variational (EnVar) data assimilation purposes.

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	VaVo, GrRo,		IAL	
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, FlMe,			12/26
E10.5	Design and implement tools that allow for the interactive exploration of ensemble covariance structures. Use these tools to evaluate the effects of different perturbation strategies (e.g., model error, surface perturbations, lateral boundary conditions) on the covariances. Assess the implications of these perturbations methods for the potential use of the ensembles in flow-dependent data assimilation (DA) methods.				
E10.6	Preparation of flow-dependent B-matrix for local 3D-Var assimilation systems based on ALARO CSC using A-LAEF operational outputs		non-t-code		
E10.8	Explore the use of EPS forecasts to run an EnVar with or without running a dedicated DA ensemble. Test what perturbations are suitable and perform the best. Link with DA6.3 and DA6.5				

ACCORD WorkPackage description : E11

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
GeSm,	Geert Smet,	RMI Belgium	0.25
HeFe,	Henrik Feddersen,	DMI Denmark	1
ZsSz,	Zsofia Szalkai,	HungaroMet Hungary	2
AnSi , HaMc,	Andrew Singleton, Harold McInnes,	MET Norway	7.5

WP objectives and priorities

Refine the surface perturbations and make them more realistic. This includes both perturbations to surface initial conditions and to parameters of the surface physics, including SPP-type perturbations.

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)**
E11.2	Continue work on extending SPP to surface parameters.	GeSm, AnSi , HaMc,	First implementation	IAL	12/26
E11.4	Implementation of surface perturbations to AROME-EPS at Hungaromet	ZsSz,			
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		
E11.8	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				

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	10
KaKe,	Katarina Keerd,	ESTEA Estonia	1

WP objectives and priorities

Optimize use of lateral boundaries from global ensemble models. For the small domains that are typically used for hectometric models, the impact of lateral boundary conditions become increasingly dominant. The impact of lateral ensemble boundary conditions on ensemble spread for small, high-resolution domains needs to be studied, and possibly the lateral boundary conditions modified.

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)**
E12.1	Improvements of the global ARPEGE-EPS that improve AROME-EPS through the lateral boundary coupling.	PiCe, LaDe, CaLa, KaKe			
E12.2	Impact of lateral ensemble boundary conditions on ensemble spread for small, high-resolution domains.		Report		12/26

ACCORD WorkPackage description : MQA1

WP number	Name of WP
MQA1	Development of HARP
WP main editor	**Carl Fortelius, Andrew Singleton, Carlos Peralta, James Fannon, Ahto Mets, Jana Sánchez Arriola**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PoSc,	Polly Schmederer,	GEOSPHERE Austria	1.5
AlDe, GeSm,	Alex Deckmyn, Geert Smet,	RMI Belgium	1.5
CaPe,	Carlos Peralta,	DMI Denmark	1.25
AhMe,	Ahto Mets,	ESTEA Estonia	1
AnSi ,	Andrew Singleton,	MET Norway	1.5
NewcomerAEMET1,	Elias Pinto ,	AEMET Spain	3

WP objectives and priorities

Exploring verification methods suitable for evaluation of data-driven models/applications and allowing a fair comparison to physics-based counterparts: evaluation based on summary measures like the rmse must be complemented by using scale aware metrics and investigations into the physical realism of data driven forecasts, especially wrt extreme events.

Descriptions of tasks

				About code deliverables (if any)	
Task	**Description**	**Participant abbrev.**	**Expected outcomes for this year**	**Code contrib to repository**	**Expected delivery (MM/YY)**
MQA1.1	**Harp User Support** The harp slack channels will continue to be the principal way for harp-users to get immediate peer-support. Additionally, the harp community will continue to meet online to exchange news and make plans. Activities of this task include: Compiling 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. Enhancing and building new automatically-generated pkgdown websites for each of the harp packages (in particular harpSpatial) to include all function documentation and package vignettes describing common use cases. Building a website to share code extracts for specific uses of harp functions and options for ingesting data types of general interest Organising a Harp workshop that will present recent developments and provide participants with hands-on experience in applying these capabilities to tasks within their areas of interest	PoSc, AhMe, AnSi ,	documentation, tutorials, peer support		
MQA1.2	**Harp code development** Code developing will focus on specific additions and improvements. Unit tests for harp functions will be built and useful scores, such as the U.UI spread-skill condition based on U-statistics of bias corrected forecasts and a Best Linear Unbiased Estimate of the truth.	PoSc, AlDe, AnSi ,	code updates	harp	continuous
MQA1.3	**Harp enhancements** This task covers the implementation of new capabilities (data ingest, metrics, display) into Harp, including results obtained in WP MQA2. Such activities include: Interfacing data that supports scale-selective verification (such as gridded high-resolution analyses, precipitation estimates from IMERG and OPERA, OPERA reflectivity data, and data from satellite instruments used as radiances or as retrieved properties of clouds and hydrometeors) to Harp by utilising existing Python packages Developing visualisation tools for Harp results using a Plotly/Dash framework in Python - we aim to leverage existing solutions developed outside of ACCORD wherever possible, extending them to support scale-aware (spatial) verification methods and enable automatic generation of presentations and textual reports. Adding functionality for wind farming verification using open source data, beginning with Borssele lidar and ENTSO-E power data from the North Sea area	AlDe, GeSm, CaPe,	code updates	harp	

MQA1.4	**Harp applications** Maintaining the common point verification workflow available in oper-harp-verif and incorporating new capabilities, in particular migration to Parquet, improved threshold verification, and the addition of conditional verification. Requests for new features from users, e.g. through the harp slack channel, will also be considered on an ongoing basis. Utilising data types and observation operators already in use for data assimilation. The aim is to set up an instance of the common scripting system for controlling the comparison of forecasts to observations and storing results in databases that can be made readable to Harp. This workflow will be implemented in a common infrastructure for MQA (see MQA5). Further developments of the Panelification tool (TBC)	NewcomerAEMET1,	Updates to oper-harp-verif, harpuserScripts and other common software	harp	

ACCORD WorkPackage description : MQA2

WP number	Name of WP
MQA2	Development of new methods for verification and validation
WP main editor	**Carl Fortelius, Jeanette Onvlee**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PhSc,	Phillip Scheffknecht,	GEOSPHERE Austria	2
PhSc,	Phillip Scheffknecht,	GEOSPHERE Austria/D	2
ThVe, MiVa, DvdB,	Thomas Vergauwen, Michiel Vanginderachter, Dieter Van Den Bleeken,	RMI Belgium	2
CaPe, CaPe, HaSc, HeFe, HeFe, KaTø, MaFr, MaFr,	Carlos Peralta, Carlos Peralta, Hauke Schulz, Henrik Feddersen, Henrik Feddersen, Kasper Tølløse, Martin Frølund, Martin Frølund,	DMI Denmark	5
KaKe, TaTa,	Katarina Keerd, Tauno Tamm,	ESTEA Estonia	2
FlSu,	Florian Suzat,	Météo-France	1
SoOh, DaTa, ViLo,	Soma Olah, David Tajti, Virag Lovasz,	HungaroMet Hungary	10
BaAl,	Badreddine Alaoui,	Maroc Meteo	2
WdR, AdVe, NaTh,	Wim de Rooy, Adithya Vemuri, Natalie Theeuwes,	KNMI Netherlands	2
RoSc, NiHa, BeRy, AkJo,	Ronald Scheirer, Nina Håkansson, Bengt Rydberg, Åke Johansson,	SMHI Sweden	5

WP objectives and priorities

Users and developers of numerical weather prediction systems both rely on comparison of model results to actual data, or verification, but in different ways. For users it is essential to know how closely forecasted parameters can be expected to match what actually occurs, and this is typically estimated by statistical analysis of the correspondence between forecasts and data, often spanning extended periods of time and covering large domains. For developers, by contrast, the main purpose of verification is to assess how well a model or sub model is able to simulate the processes and interactions it is intended to represent, and to suggest improvements where needed. These latter purposes of model validation and error attribution require a process oriented verification often relying on special observations covering,e.g, fluxes and vertical profiles, particle concentrations and size distributions etc.

Advances in the fields of verification methods and observing techniques, the progress of numerical weather prediction models towards ever higher resolution and the accompanying new types of applications, as well as the emergence of data driven forecasts all contribute to making it possible and necessary to develop the verification systems constantly. This work package concerns the development and trial of new methods and data intended to be applicable in the frame of common codes and workflows in use for the purposes of forecast verification and model validation within ACCORD.

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)**
MQA2.1	**Process oriented verification** Building a stepwise process-oriented verification system by bringing in, and assessing for several processes, suitable combinations of process-relevant observations, model parameters and metrics. Make use of observations from dedicated networks such as: Cloudnet, CLARA and Surfnet and from satellites such as Calypso and Earthcare. This work should be harmonised with efforts in MQA5 and relevant packages from the areas of upper air physics and surface.	FlSu, WdR, AdVe, NaTh, RoSc, NiHa, BeRy, AkJo,			
MQA2.2	**Synergies with data assimilation** Extending the pool of observations available for routine forecast verification by utilising observation operators and screening methods applied in data assimilation. Start exploring what can be learned from comparing in this way forecasts to non-conventional observations such as radiances at various frequencies.	KaTø, FlSu,			
MQA2.3	**High impact weather** Developing 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. Make use of automatic pattern recognition and Lagrangian-based methods for evaluation of extreme convective events. 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.	PhSc, ThVe, CaPe, HeFe, MaFr, DaTa, ViLo,			
MQA2.4	**AI and data driven forecasts** Exploring verification methods suitable for evaluation of data-driven models/applications and allowing a fair comparison to physics-based counterparts: evaluation based on summary measures like the rmse must be complemented by using scale aware metrics and investigations into the physical realism of data driven forecasts, especially wrt extreme events.	MiVa, DvdB, CaPe, HaSc, HeFe, MaFr, SoOh, BaAl, AkJo,			

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,	Zahra Belkacimi,	ONM Algeria	1
PhSc, BrGo,	Phillip Scheffknecht, Brigitta Goger,	GEOSPHERE Austria	3.5
MaHr, EnKe, IrOd, IvVu,	Mario Hrastinski, Endi Keresturi, Iris Odak, Ivan Vujec,	DHMZ Croatia	4.75
HeBe, CaCh, MiGl, PaLa, VeMa, PiBr, MaDe, NiGi, VaVo, YvBo, InEt, SoMa, MaMa, AdNa, BeBo, MeWi,	Herve Benichou, Camille Choma Bex, Michael Glinton, Pascal Lamboley, Veronique Mathiot, Pierre Brousseau, Mayeul Destouches, Nicole Girardot, Valerie Vogt, Yves Bouteloup, Ingrid Etchevers, Sophie Marimbordes, Marie Mazoyer, Adrien Napoly, Bertrand Bonan, Meryl Wimmer,	Météo-France	56
NSzG,	Natalia Szalontaine Gaspar,	HungaroMet Hungary	1
EmGl, EoWh,	Emily Gleeson, Eoin Whelan,	MET Eireann	1
NaMa,	Najlae Marass,	Maroc Meteo	2.5
JeOn,	Jeanette Onvlee,	KNMI Netherlands	2
JoRi, MaMo, MaBe, JoCr,	João Rio, Maria Monteiro, Margarida Belo, José Cruz,	IPMA Portugal	1.75
MiPa, BeCa,	Miguel Pardal, Beatriz Carvalho,	IPMA Portugal/D	1.25
SiTa, AlCr, MiOp,	Simona Tascu, Alexandra Craciun, Mihail Oprea,	Meteo Romania	6.5
AnSi,	Andre Simon,	SHMU Slovakia	1
JaCa,	Javier Calvo,	AEMET Spain	2
WaKh, HaDh, RaBR,	Wafa Khalfaoui, Hajer Dhouioui, Rahma Ben Romdhane,	INM Tunisia	6
ZeÜn, CeKı,	Zeynep Feriha Ünal, Celaleddin Kızılkaya,	MGM Türkiye	2

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. The results of evaluation must be compared with reliable references (benchmarks). 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 with sources of high-quality spatially dense in-situ data such as aircraft, and with retrievals of cloud properties and precipitation from earth observation systems. Differences in results of new and pre-existing model versions 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 periods 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 processing, 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.

The efforts described in this WP will be monitored and accounted for in the CEpQA item required by the ACCORD/MoU. [1]

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, PhSc, BrGo, MaHr, EnKe, IrOd, IvVu, HeBe, CaCh, MiGl, PaLa, VeMa, PiBr, MaDe, NiGi, VaVo, YvBo, SoMa, MaMa, AdNa, BeBo, MeWi, NSzG, EoWh, NaMa, SiTa, AlCr, MiOp, 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.	PhSc, BrGo, LeLa, EvMa, VeLi, LePf, FaSt, MaTa, MiZa, YvBo, InEt, SoMa, MaMa, AdNa, BeBo, MeWi, EmGl, MiPa, JoRi, MaMo, MaBe, JoCr, 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.		Inventory		
MQA3.4	Work out common recommendations for validation of components and entire models.	JeOn,	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.		Documents		

ACCORD WorkPackage description : MQA4

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, MoAe,	Zahra Belkacimi, Mohamed Aeumeur,	ONM Algeria	3
ChWi, ClWa, AlRa,	Christoph Wittmann, Clemens Wastl, Alexander Radlherr,	GEOSPHERE Austria	2
AlDe, IdDe, GeSm, MiVa,	Alex Deckmyn, Idir Dehmous, Geert Smet, Michiel Vanginderachter,	RMI Belgium	2.5
BoTs,	Boryana Tsenova,	NIMH Bulgaria	1
KrNo,	Kristina Klemenčić Novinc ,	DHMZ Croatia	0.25
AhMe, KeSi,	Ahto Mets, Kertu Sild,	ESTEA Estonia	2
EeSa,	Eerik Saarikalle,	FMI Finland	3
FaDu, LeLa, EvMa, VeLi, LePf, FaSt, MaTa, MiZa, InEt,	Fabrice Dupont, Lea Launay, Eva Marques, Veronique Lion, Leo Pfitzner, Fabien Stoop, Maxime Taillardat, Michael Zamo, Ingrid Etchevers,	Météo-France	45
BoTo, NSzG,	Boglarka Toth, Natalia Szalontaine Gaspar,	HungaroMet Hungary	4
EoWh, JaFa, RóDa,	Eoin Whelan, James Fannon, Rónán Darcy,	MET Eireann	1.75
KrKr,	Kristina Kryžanauskienė,	LHMS Lithuania	4
FaHd,	FatimaZahra Hdidou,	Maroc Meteo	1.5
GuNo,	Gunnar Noer,	MET Norway	0.5
BoBo, PiSe, GaSt, MaSz, NaSz, MaKo, JaRo, AgWo,	Bogdan Bochenek, Piotr Sekuła, Gabriel Stachura, Małgorzata Szczęch-Gajewska, Natalia Szopa, Marcin Kolonko, Jadwiga Róg, Agata Wojtkiewicz,	IMGW Poland	16
MaLo, JoRi, VaCo, PeSo, MaBe,	Manuel João Lopes, João Rio, Vanda Costa, Pedro Sousa, Margarida Belo,	IPMA Portugal	2.75
SiTa, AlCr, MiOp, MeAn,	Simona Tascu, Alexandra Craciun, Mihail Oprea, Meda Andrei,	Meteo Romania	2
JuCe, NePr, TiKo,	Jure Cedilnik, Neva Pristov, Timotej Kozelj,	ARSO Slovenia	6.5
OnDo, FaBü, NN_TSMS,	Onur Hakan Doğan , Fatih Büyükkasabbaşı, Newcomer_TSMS,	MGM Türkiye	5

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 organise the analysis and response to the feedback. Reports and response will be posted on a dedicated page of the ACCORD wiki. 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.

The efforts described in this WP will be monitored and accounted for in the CEpQA item required by the ACCORD/MoU.

Descriptions of tasks

Task	Description	Participant abbrev.	Expected outcomes for this year	Code contrib to repository (About code deliverables (if any))	Expected delivery (MM/YY)
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, ChWi, ClWa, AlRa, AlDe, IdDe, GeSm, MiVa, BoTs, EeSa, FaDu, LeLa, EvMa, VeLi, LePf, FaSt, MaTa, MiZa, InEt, BoTo, NSzG, EoWh, JaFa, RóDa, FaHd, BoBo, PiSe, GaSt, MaSz, NaSz, MaKo, JaRo, MaLo, JoRi, VaCo, SiTa, AlCr, MiOp, JuCe, NePr, TiKo, 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 displaying the feature in question and references to related observations and model output. They distribute among their local user community the response of the ACCORD organization to the collected feedback and participate in ACCORD user meetings.	MoAe, KrNo, AhMe, KeSi, EeSa, FaDu, BoTo, NSzG, KrKr, GuNo, AgWo, MeAn, TiKo, NN_TSMS,	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, BoBo, PiSe, GaSt, MaSz, NaSz, MaKo, JaRo, PeSo, MaBe, JuCe, NePr,	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**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
PM	Claude Fischer	(not relevant)	
LeDe,	Leif Denby,	DMI Denmark	0.25
BaAl,	Badreddine Alaoui,	Maroc Meteo	2
JeOn,	Jeanette Onvlee,	KNMI Netherlands	2.75
UlAn, DaYa,	Ulf Andrae, Daniel Yazgi,	SMHI Sweden	5

WP objectives and priorities

In coherence with the ACCORD 2026-2030 scientific strategy 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 gather and analyse experiences from a prototype ~~a~~ solution implemented in the frame of the ECMWF Special Project SPFRACCO and serving principally process-oriented verification. Thus we will:
- 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.

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)
MQA5.1	Study a prototype of the work environment				
MQA5.2	Work out a sustainable long term solution for the work environment, that can later be maintained in the frame of system activities, and develop the prototype accordingly.				
MQA5.3	Analyze the needs for using the MQA-benchmark and the MQA-infrastructure for the evaluation of data driven models	LeDe, BaAl, JeOn, UlAn, DaYa,			
MQA5.4	Pending on progress in the design, evaluate the resource requirements that may require governance discussions (maybe based on scenarii of different levels of cost)				

ACCORD WorkPackage description : SY1

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

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
DaDe,	Daan Degrauwe,	RMI Belgium	2
DeHa,	Denis Haumont,	RMI Belgium/D	1
RuMa,	Rudolf Mård,	FMI Finland/D	1
RyEl, SoBi,	Ryad El Khatib, Soline Bielli,	Météo-France	8.5
BaSa,	Badr Sabir,	Maroc Meteo	2
OlSp,	Oldrich Spaniel,	SHMU Slovakia	5
UlAn, DaYa, SwMa,	Ulf Andrae, Daniel Yazgi, Swapan Mallick,	SMHI Sweden	2.5

WP objectives and priorities

To enhance efficiency and prepare for future high-performance computing environments, ACCORD is adopting a comprehensive strategy focused on performance benchmarking, code portability, and optimization. A central aspect of this effort is the systematic profiling of the model with each new development cycle. This includes performance evaluations on a wide range of massively parallel systems to identify and overcome computational bottlenecks. These profiling exercises are not limited to the model as a whole but extend to individual components, allowing for targeted optimizations where the greatest efficiency gains can be achieved.

Compilation-based optimizations are an integral part of this strategy. These include improvements in compiler flag configurations, restructuring of computational loops, and better memory management to reduce latency and increase bandwidth efficiency.

The model's increasing reliance on advanced data assimilation methods like 4DVar and EnVar requires a thorough evaluation of their computational cost and efficiency. These methods, while improving the accuracy of forecasts, also place significant demands on computational resources. Therefore, optimizing their implementation is essential to ensure their feasibility in operational settings.

Another important area under investigation is the impact of using single versus double precision in numerical calculations. The aim is to define the priority configurations for testing, establish guidelines for acceptable trade-offs between precision and performance, and outline protocols for evaluating accuracy and reproducibility under single precision conditions

Input/output performance also presents a major challenge to scalability in numerical weather prediction models. Reading initial and boundary conditions and writing forecast fields can significantly hinder performance. More efficient I/O operations can be achieved by designating specific nodes for I/O tasks, introducing asynchronous I/O mechanisms, and minimizing redundant file format transformations.

Supporting tools involved in the data assimilation workflow, such as those for observation preprocessing and conversion, also contribute to overall computational cost. Regular profiling of these tools is necessary to ensure they do not become bottlenecks in the operational chain.

Portability in our multiplatform codes aims to ensure optimal performance across all systems using a single codebase, with minimal dependence on platform-specific modifications.

Descriptions of tasks

Task	Description	Participant abbrev.h	Type of deliverable	About code deliverables (if any): Code contrib to repository	About code deliverables (if any): Expected delivery (MM/YY)
SY1.1	**Regular benchmarking and reproducibility monitoring of the NWP codes, as well on CPU as on GPU**	RyEl, OlSp,	No		
SY1.2	**Code Optimisations** 1. Non-intrusive optimisations:Performance improvements made without modifying the core logic of the source code: - Fine-tuning compiler options externally - Using compiler directives within the source code (e.g. for loop unrolling, vectorization hints) 2. Intrusive optimisations:Changes made directly to the source code that provide performance benefits across architectures: - Loop pipelining or SIMD vectorization - Reducing memory bandwidth usage by eliminating unnecessary data initializations or copies - Improving memory locality through caching strategies	RyEl,			
SY1.3	**Profiling and optimisation of data assimilation configurations used for operational purposes** (e.g. OOPS, 4DVar, EnVar …)	RyEl,	Non-t-code		
SY1.4	**Code Redesign:** High-level restructuring, revisiting interfaces to improve modularity, or externalizing components. These efforts are typically part of long-term projects, such as OOPS, porting to GPU architectures, or ensuring long-term code maintenance	RuMa, RyEl, SoBi, OlSp,	T-code?		
SY1.5	**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	BaSa,	t-code		
SY1.6	**Profiling of NWP tools that are on the critical path of operations** (e. g. ObsConvert)				
SY1.7	**Code portability**: ensuring optimal performance accross all systems with a single codebase and minimum platform specific code.		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
EmAl, MaDa, SoTh,	Emy Alerskans, Mats Dahlbom, Søren Borg Thorsen,	DMI Denmark	3.25
MiHa,	Mikael Hasu,	FMI Finland	1.5
EoWh, CoDa,	Eoin Whelan, Conor Daly,	MET Eireann	5
CrRo, CrRo, BeUl,	Chris Romick, Chris Romick, Bert van Ulft,	KNMI Netherlands	7.5
JaSn,	Jacob Snoeijer,	KNMI Netherlands/D	1
RoMy,	Rolf Myhre,	MET Norway	1
DaYa, SwMa,	Daniel Yazgi, Swapan Mallick,	SMHI Sweden	1.5

WP objectives and priorities

The Harmonie Reference System is the operational foundation for both deterministic and ensemble (EPS) numerical weather prediction within the Unified Weather Centres (UWC) collaboration. It includes not only the forecast model source code but also the full suite of scripts, utilities, and documentation required to run and maintain a complete forecasting system in real-time environments.

A key objective for UWC is to maintain a technically robust and operationally validated Harmonie Reference System. As part of the version declaration process, one or more UWC member services commit to implementing the latest full release of the Reference System as their operational forecasting suite. These lead centres play a crucial role in demonstrating that each new system version meets operational standards for reliability, reproducibility, and meteorological performance. Originally focused solely on deterministic forecasting, the commitment now also includes HarmonEPS, reflecting its full integration into the system.

To support this, each Reference release undergoes pre-operational testing on active model domains. This ensures early identification of issues and reduces the divergence between the central Reference System and operational implementations. To strengthen operational alignment, broader staff involvement is encouraged in the pre-release porting, testing, and tuning phases across UWC partners reported under COM3.1.

While the Harmonie-Arome forecast model, written in Fortran, remains the core of the system, the Reference System extends far beyond it. It includes scripting systems, data assimilation components, EPS configurations, and supporting utilities—all essential for operational deployment. The development and maintenance of these components are coordinated through joint efforts under work packages COM2.1 and COM2.T.

The integration of new utilities such as pysurfex, Titan, and GribPP into the Reference System requires adaptation of scripts and test suites to ensure full system compatibility and operational reproducibility. These developments help modernize the system and expand its capabilities.

The transition to GitHub as the system's source code manager has enabled improved version control and collaboration workflows. This includes the ongoing restructuring to separate model code from scripting and support tools, facilitating the creation of a dedicated harmonie fork within the IAL repository. A new bundling tool now supports streamlined system builds by linking components from independent repositories, a key step towards more modular and maintainable operational deployments.

Looking forward, UWC efforts are also directed at enhancing post-processing and verification systems. This includes improving tools such as gl and transitioning to the HARP verification suite, which offers a more modern and scalable framework suited to operational needs.

In summary, the Harmonie Reference System is being developed and maintained not just as a shared scientific resource, but as a production-ready, adaptable, and high-performance forecasting system ready for continuous use in operational meteorology across all UWC partners.

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	**Implement, monitor, validate, and test new code contributions for the Reference System.** - Release and maintain code, scripting, and tools associated with the Reference System. - Conduct technical testing, including regular testbed runs at ECMWF. - Integrate new code and phase it to the latest available T cycle. - Test the injection of observation data - Ensure meteorological equivalence of the Reference System across platforms.	EmAl, SoTh, MiHa, EoWh, CoDa, BeUl, RoMy,	Non-t-code	other repo	
SY2.2	**Establish a procedure between HAR MG and the operational groupings to test and run a Harmonie reference**		Non-t-code	other repo	
SY2.3	**Technical support and trouble-shooting for Harmonie-Arome system to ensure smooth operational running.** - Issue tracking		Non-t-code	other repo	
SY2.4	**Implement Harmonie CSC tests in Davaï testing tool on ECMWF and Belenos**	CrRo,	Non-t-code	DAVAI-tests	
SY2.5	**Transition and assess for harmonie cmake to ACCORD common building system**		Non-t-code	other repo	

SY2.6	**Harmonie 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.	EoWh,	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 fork 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. - Reconsider the submodule strategy and align it with the CI strategy for CY50T2 onwards	JaSn,	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-49T2h1 declaration through block and system testing - Introduce MQA workflow (HARP based) for block and system testing to create Harmonie CSC version which produces meteorologically reasonable results, as code base for scientists to build upon (no full MQA and optimization for operations yet) - Explore the possible coexistence of harmonie scripting and DEODE scripting system	MaDa, MiHa, CrRo,	T-code	DAVAI-tests	
SY2.11	**Post-processing improvements:** - 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. - Explore the use gl vs fullposs to have a more efficient postprocessing workflow with the dev managers of the UWC groupings	SoTh, CoDa,	Non-t-code	other repo	
SY2.12	**More portable versions of harmonie (Eoin)??** - Working on Containers using (rootless) for MUSC and Harmonie	EoWh,	Non-t-code	other repo	
SY2.13	**Perform the adaptations needed to phase out Monitor.** - The 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 and panelification.		Non-t-code	harp	

ACCORD WorkPackage description : SY4

WP number	Name of WP
SY4	Roadmap tasks for developing an ACCORD common scripting
WP main editor	**Daniel Santos-Munoz, Claude Fischer**

Table of participants

Participant Abbreviation	Participant	Institute	PersonMonth
AlDe,	Alex Deckmyn,	RMI Belgium	3
MiTs, KoMl, BoTs,	Milen Tsankov, Konstantin Mladenov, Boryana Tsenova,	NIMH Bulgaria/D	7
MaFr,	Martin Frølund,	DMI Denmark	0.75
ThLe, AlMa, FlSu,	Thibault Lestang, Alexandre Mary, Florian Suzat,	Météo-France	4.5
LuAu, NiCo,	Ludovic Auger, Nicolas Coutand,	Météo-France/D	14
JaSn, JaSn,	Jacob Snoeijer, Jacob Snoeijer,	KNMI Netherlands/D	5
MaMo,	Maria Monteiro,	IPMA Portugal	0.25
MiPa,	Miguel Pardal,	IPMA Portugal/D	1.25
BeSt,	Benedikt Strajnar,	ARSO Slovenia	1
NiKa,	Nika Kastelec,	ARSO Slovenia/D	8
UlAn, NNse,	Ulf Andrae, Newcommer_SMHI2,	SMHI Sweden/D	4

WP objectives and priorities

As highlighted in the ACCORD Strategy, the adoption of a common scripting system is a key objective of phase 2. The common scripting will facilitate R&D collaboration across ACCORD teams. It can be considered by the teams for local use although this will not be mandatory, neither for research nor for operations. It will however ease local installation of complex configurations such as EPS or DA, and increase the level of meteorological quality assurance by enabling teams to use and/or compare similar workflows.

The development of the scripts will follow the milestones described in the "common scripting roadmap" elaborated in the first half of 2025 by a dedicated task force. The roadmap also describes the estimated staffing and expertise resource requirements needed in ACCORD (note: including resources *not* otherwise assigned to DEODE-own objectives and deliverables).
This Work Package reflects the set of tasks planned for 2026 as defined in that roadmap. It is recommended to any reader of this WP sheet to also consult the roadmap available here.

It is expected that this work will span over 2026 and 2027, and the description of the tasks may evolve as we will learn from the process and make progress. New development tasks likely will have to be defined for the following years (some of the tasks for 2026 actually are analysis tasks at first).

An important aspect for ACCORD to be successful in this development is that a small set of persons can be identified in order to form from 2025 on a "scripting technical team". The estimated size of the team is 3 persons at the start (1 per CSC), then plus 1 (obs) and again plus 1 (DA). We are looking for people with motivation for digging into software (mostly python programs), studying workflow tools and developing complex NWP workflow scripting from existing examples. Expertise-building on DEODE scripting, on other existing workflow tools and on how to run NWP models in the ECMWF and in the MF HPC environments will be necessary. Conversely, NWP scientific experts in spe are not required for 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)
SY4.1	**Use of the DEODE scripts to run a forecast of each of the 3 CSCs using an IAL-code version.** The target IAL code version is CY50T1 or any other recent code version, similar for the 3 CSCs, on the ECMWF and on the MF machines. - Prepare and run one reference forecast for each CSC in their “usual” environment and using CY50T1, both at ECMWF and at MF. - Run forecasts for each of the 3 CSCs using DEODE scripts and an IAL-code version (CY50T1) on ECMWF and MF machines. - Implement and test the global-to-LAM coupling (creation and use of LBC files)	AlDe, MiTs, KoMl, BoTs, MaFr, LuAu, NiCo, JaSn, MiPa, NiKa,			
SY4.2	**Enable Coupled Experiment Creation (LAM from Global or LAM).** Be able to create a new experiment using as input data the output data from a previous experiment (the experiments may not be of exactly the same nature). - Step 1: ACCORD learns how to use these scripts in the MF environment. ACCORD also has to learn how the “coupling” functionality works in the MF scripting. - Step 2: ACCORD further analyzes the “coupling feature” using IAL-code versions, and proposes an adaptation with the DEODE scripts. A cross-check of the proposed design with several other ACCORD teams could help strengthen the proposal and ensure the need is well covered. - Step 3: Implementation of the proposed solution.	LuAu, NiCo, ThLe, NiKa,			
SY4.3	**“Clim” and PGD File Configuration Testing.** - Analyze and test script support for generating “clim” and PGD files at ECMWF and MF machines. - Complement the initial DEODE documentation with ACCORD relevant information.	LuAu, NiCo, FlSu,			

SY4.4	**Establish a Static Data Portal ("quick solution")** Establish a Static Data Portal (Version-Controlled - Preliminary prototype as a "quick solution"). This task is not directly linked with the scripts but will be very useful in the mid-to-long term future. It directly relates to the modernization of the working practices. - Develop a centralized data portal for version-controlled static datasets (e. g., input physiography databases for "clim"/PGD files, RT-coeff files etc.). - Improve traceability, collaboration, and compatibility with common scripts.	LuAu, NiCo, ThLe, AlMa,			
SY4.5	**(Second) Knowledge Transfer from DEODE to ACCORD** The first knowledge transfer will be organized in 2025. In this task, the ACCORD initial technical team for scripting organizes an initial workshop/tutorial/working days to ensure transfer of knowledge to some local teams - Include both technical deep-dives and practical sessions - Preparatory step to ensure the initialization of SY4.6	AlDe, MiTs, JaSn,			
SY4.6	**Local Implementation of Scripts.** Implement and test scripts at other sites than ECMWF or MF by the trained local teams from SY4.5	AlDe, MiPa,			
SY4.7	**EPS Configuration.** Transfer of knowledge of EPS implementation under Deode scripts including the implemented perturbation methods. - Test at ACCORD level the EPS features. - Analyze what a baseline version of the ACCORD scripts for EPS could be.				
SY4.8	**Observation Handling Prototyping.** ACCORD should provide a common scripting solution able to comply with all main standard observation formats (ie originating from international organizations or collaborations). The proposal conversely is ***not*** to try to adapt it to each local obs format (format meaning data and metadata). It is still open where precisely in the observation workflow, the ACCORD common scripting and tools should start. This task is to further analyze this aspect and make a proposal. - Analyze the starting point for obs handling in the common scripting design. - Pending on the outcome of the above analysis on the starting point, investigate the design and the prototyping of functions such as: - Creation of an ODB file - Screening-based verification - Screening functions - Surface analysis (e.g., CANARI - Provide an estimation of the manpower required for completing the design and for implementing the prototypes for the chosen functionalities				
SY4.9	**Data Assimilation baseline configuration.** Adaptation of the ACCORD scripts to a baseline DA configuration able to utilize a large range of observations as defined in SY4.8 - Define a simple but representative DA system to use as a reference. For instance, start with CANARI coupled with OI_MAIN for surface assimilation, and 3D-Var for upper-air assimilation. Only consider conventional observations at first, but rapidly extend the range of observations to span all obs types expected in research. - Possible specific Functionalities to consider for design and prototyping are: - Computation and diagnostics of the B matrix - Analyze script requirements for DA cycling - Include basic diagnostic tools to monitor the assimilation performance - Identify key components to adapt - Draft a complementary DA-focused work plan - Provide an estimation of the manpower required for completing the design and for implementing the prototypes for the chosen functionalities.	MiPa, MaMo, BeSt, NiKa,			
SY4.10	**Establish a Static Data Portal (Final solution)** Static Data Portal (Version-Controlled) (Final release) Develop a centralized data portal for version-controlled static datasets (e.g., input physiography databases for "clim"/PGD files, RT-coeff files etc.). - Improve traceability, collaboration, and compatibility with common scripts. - Final solution to be maintained.				

[1] For the paragraph 4, I suggested to mention the references (benchmarks) as proposed by Meto on the ASW donference (https://drive.google.
com/drive/folders/1pxZg9nxHKnudmgbT49S_jeDeuxvwN9k_)