

LATE REQUEST FOR A SPECIAL PROJECT 2026–2028

MEMBER STATE: Croatia

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Project Title:

ALARO+ SURFEX – coupling ALARO upper air physics package with the SURFEX land surface scheme

To make changes to an existing project please submit an amended version of the original form.)

If this is a continuation of an existing project, please state the computer project account assigned previously.	Spcralae	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2026	
Would you accept support for 1 year only, if necessary?	YES <input checked="" type="checkbox"/>	NO <input type="checkbox"/>

Computer resources required for project year:

	2026	2027	2028
High Performance Computing Facility [SBU]	45 M	45 M	45 M
Accumulated data storage (total archive volume) ² [GB]	45000	60000	75000

EWC resources required for project year:

	2026	2027	2028
Number of vCPUs [#]			
Total memory [GB]			
Storage [GB]			

¹ The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide annual progress reports of the project’s activities, etc.

² These figures refer to data archived in ECFS and MARS. If e.g. you archive x GB in year one and y GB in year two and don’t delete anything you need to request x + y GB for the second project year etc.

³ The number of vGPU is referred to the equivalent number of virtualized vGPUs with 8GB memory.

Number of vGPUs ³	[#]			
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Continue overleaf.

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Extended abstract

In the framework of ACCORD Consortium, the common code encompasses three upper air physics packages developed by LAM community – ALARO, AROME and Harmonie-AROME. The latter two utilize SURFEX to describe the evolution of surface variables. ALARO has been using old ISBA scheme that has been frozen for developments for some time.

In order to run the ALARO Canonical Model Configuration coupled with SURFEX in model forecast, climate simulations or data assimilation and cycling, there was considerable effort done over more than ten years up to now. However, not a single operational ALARO application utilizes SURFEX to describe surface processes and interactions with the surface. This is a consequence of many factors:

- ALARO physics has been evolving over the years and it was necessary to extend some upper air schemes all the way into SURFEX, like coding the turbulent exchange mechanism into SURFEX*
- SURFEX evolved rapidly between different versions, with surface, any a new version yielding different vegetation types often related number of tiles and patches to describe the surface and based on different surface databases that have an evolution of their own*
- ALARO physics allows for very long timesteps that are not suitable for some schemes in SURFEX, especially more advanced ones that would actually pose a benefit towards the ISBA scheme currently used with ALARO.*
- Furthermore, there are many (rather crude) assumptions needed to run SURFEX in a stable and reliable way and it is wished to avoid them in the ALARO physics package, therefore a lot of code cleaning and debugging was applied to the SURFEX code*

The project participants wish to utilize ECMWF HPC system with its computing and storage capabilities as a common working platform to exchange developments, experiments and data needed for further developments in coupling ALARO with SURFEX, particularly:

- to utilize the most recent ECOCLIMAP SG data*
- experiment with different initial surface data*
- run tests on different domains (some areas were found to be problematic)*
- support in making cases for MUSC single column model*
- explore the snow scheme of SURFEX and its interaction with the next point*
- explore utilization of TEB (Town Energy Balance) scheme and*
- MEB (Multi Energy Balance).*

In order to achieve the above, it is first needed to build an experimental framework for testing for which there are already few examples to start from, like the test implemented in DAVAI or the experimental setup of DE-330 LAM component that allows to run at least some experiments using ALARO with SURFEX.

The initial step of having a specific and targeted training on how to use SURFEX with ALARO physics was organized in June 2025 on the premises of CHMI https://opensource.umr-cnrm.fr/projects/accord/wiki/ALARO+SURFEX_WW_2025 where a brief tutorial led to extensive experiments with prepared jobs that participants could modify and were running on the belenos machine of Meteo France. As the outcome of the working week:

- technical tests involved FULLPOS-PREP as easy but not recommended solution
- functionality of PREP from ARPEGE to LAM was tested, we succeeded to transform v8.0+ ARPEGE PREP file to v8.1+ LAM PREP file
- participants successfully tested ALARO with SURFEX for some of their operational domains, but
- there were issues with ALARO+SURFEX run were encountered on Turkey 4500m domain, they persisted even with ARPEGE like configuration (1 nature patch, no TEB, ECOCLIMAP I)
- functionality of ORORAD with ACRANEB2 radiation in NWP configuration configuration was tested successfully, yet thorough verification to examine its impact is needed
- ECOCLIMAP SG was tried, with successful PGD run for CHMI 2325m domain, both without and with TEB
- sensitivity of TEB to industry heat sources was examined

The working week was followed by extended stays of two participants working on TEB with snow and on using the most recent ECOCLIMAP SG database for underlying data describing the surface characteristics.

Since tests on some domains did not work, like any of them covering Turkey, including the tests done with the scripts developed in the DE-330 projects, we have to explore possible problems in the surface database.

Further development would introduce the surface data assimilation and cycling of surface prognostic variables which in turn depend on the choices made to run SURFEX in all three steps: PGD, PREP and forecast.

Work on setting up similar examples on ECMWF HPC is ongoing. It requires:

- porting the code of CY49T2 including the bugfixes for SURFEX (without bugfixes, the code is able to do something, but any problems may occur due to absence of bugfixes)
- compiling viable versions of PGD, PREP and MASTERODB
- having additional tools as `epy_oro.py` and `pgd_frac` (one should also turn towns of less than 5% into nature)
- using properly working version of climake
- additional tools for conf 903 for atmospheric LBCs
- SBUs for non-full-members to be arranged through a Special Project

The scripts cover the whole chain of:

- preparation of initial and LBC files (atmospheric part)

- preparation of the PGD file that includes the additional step where where town fractions below 5% are converted to nature (needed since it uses ECOCLIMAP II)
- preparation of PREP file using Fullpos that is suitable only for technical tests as it initializes SURFEX prognostic fields from old ISBA fields, a better version should use PREP for conversion from a SURFEX (or TESSEL) file to SURFEX (see the next paragraph).
- forecast integration using ALARO with SURFEX

In the place of the third bullet above, one may want to use new demo PREP scripts that transform the operational ARPEGE PREP file to a PREP file on Czech domain (can be modified to work on other domains too). One script works for transforming from the ARPEGE PREP file made with SURFEX version 8.0+ and another one works for ARPEGE PREP files made using SURFEX version 8.1+. Beware that one has to use the proper script for a proper date (when did the switch happen, I lost the date). The LAM file generated that way is always SURFEX version 8.1+ kind of file since the output PREP file SURFEX version is driven by the SURFEX version of the target PGD file and depends on the output of the second bullet above

Surface Data Assimilation

The model forecast can be run as dynamical adaptation or using data assimilation, the same is valid for surface part. In dynamical adaptation, all prognostic variables can be initialized:

- from global model (ARPEGE SURFEX or IFS TESSL) analysis or forecast using PREP tool
- from (another) LAM model analysis or forecast (input can be running old ALADIN ISBA or SURFEX) using FULLPOS-PREP tool
- or from an offline SURFEX system (for example that is a solution used for DEODE)

Data assimilation combines the (previous model run) forecast with surface and satellite observations and creates more accurate (and balanced?) surface prognostic fields using optimal interpolation (OI), (Simplified) Extended Kalman Filter ((S)EKF), Ensemble Kalman Filter (EnKF) or OI with ensemble based coefficients.

There are several implementations of surface data assimilation in SURFEX:

- SODA is SURFEX Offline Data Assimilation is intended for offline use, creates initial file for the forecast, can use any(?) of the DA methods (source IAL/surfex/ASSIM might be externalized from CY50 ?)
- CANARI surface data assimilation, so called configuration e701, originates from the old ALADIN ISBA scheme that is currently used operationally in ALARO runs without SRUFEX, including the operational deterministic and EPS applications, (source IAL/arpifs/canari and IAL/mse/external)

There are two interfaces to CANARI, AROME France uses CANARI_SFX under switch LAEICS_SX and HARMONIE-AROME uses CANARI_SX_ICCS under switch LL_SODA.

All of the above require gridded observations as input that can be obtained using various methods, for example using two-dimensional optimal interpolation of 2m temperature and humidity within CANARI or two-dimensional EnVar within OOPS (also TITAN/gridPP and pysurfex).

SURFEX has many prognostic variables, but only some of them are analyzed.

Further work is needed as well as testing on another common platform and the ECMWF HPC would be an "easy" target for the common platform for further tests.

In the framework of this Special Project the participants would:

- set up a set of scripts for testing the whole PGD-PREP-forecast chain using ALARO with SURFEX, possibly benefiting from the existing scripting systems there – such as DAVAI and Tactus (from DE-330)*
- port the code modifications needed to run ALARO with SURFEX*
- run tests for various domains and possibly fix the problems encountered for some domains enabling colleagues from Turkey to actively participate in the effort*
- establish tests with surface data assimilation and cycling that uses CANARI within SURFEX instead of the current operational implementations of CANARI with the old ISBA scheme outside SURFEX(optional for the first year)*

Some of the preparatory steps have already been made.

All Special Project requests should provide an abstract/project description including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The completed form should be submitted/uploaded at <https://www.ecmwf.int/en/research/special-projects/special-project-application/special-project-request-submission>.

Following submission by the relevant Member State the Special Project requests will be published on the ECMWF website and evaluated by ECMWF and its Scientific Advisory Committee. The requests are evaluated based on their scientific and technical quality, and the justification of the resources requested. Previous Special Project reports and the use of ECMWF software and data infrastructure will also be considered in the evaluation process.

Requests exceeding 10,000,000 SBU should be more detailed (3-5 pages).