SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2025
Project Title:	Regional reanalysis demonstrators for Copernicus Climate Change Service Evolution
Computer Project Account:	'spnoschy'
Principal Investigator(s):	Harald Schyberg
Affiliation:	Norwegian Meteorological Institute
Name of ECMWF scientist(s) collaborating to the project (if applicable)	-
Start date of the project:	1 January 2025
Expected end date:	31 December 2026

Computer resources allocated/used for the current year and the previous one

(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	-	-	208.3M	3.5M
Data storage capacity	(Gbytes)	-	-	210 700	-

Summary of project objectives (10 lines max)

This Special Project is for computer resources for carrying out research and for running regional reanalysis demonstrators which are candidates for producing future regional reanalysis products in the Copernicus Climate Change Service (C3S). This is part of the Horizon-Europe project CopERnIcus climate change Service Evolution (CERISE) coordinated by ECMWF (see https://cerise-project.eu/). In general the CERISE project aims to enhance the quality of the C3S reanalysis and seasonal forecast portfolio, with a focus on land-atmosphere coupling. This project is specifically for the parts of CERISE developing, implementing and running regional land surface reanalysis demonstrators as well as coupled land-upper-air 3D reanalysis demonstrators over European and Arctic areas. The developments take place within the HARMONIE-AROME regional NWP code framework.

Summary of problems encountered (10 lines max)

None

Summary of plans for the continuation of the project (10 lines max)

The first upcoming task is to produce a demonstration data set with the pan-Arctic land reanalysis demonstrator called CARRA-land-Pv2 (Copernicus Arctic Regional Reanalysis - land prototype version 2). In parallell we are experimenting with candidate methods for the fully coupled 3D pan-Arctic reanalysis demonstrator CARRA3-Pv1 (CARRA3 prototype version 1), to configure a final prototype and produce a one-year demonstration reanalysis data set. Later on we will experiment with candidate methods and components for a prototype pan-European reanalysis CERRA2-Pv1 (Copernicus European Regional Reanalysis 2nd generation prototype version 1) and produce a one-year data set with that as well.

List of publications/reports from the project with complete references

None in these first six months of the Special Project.

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

The activity since the Special Project start has consisted of implementing and testing elements of data assimilation for regional reanalysis and surface upper-air coupling methodology in numerical weather prediction. Developments include preparing offline land surface only model experiments to evaluate the unified land data assimilation system applying Local Ensemble Transform Kalman Filter (LETKF) as well as preparation of coupling and assimilation strategies for full 3D reanalysis systems.

For the land surface demonstrator we have implemented the assimilation of conventional 2m temperature and snow depth observations to update soil temperature, moisture and snowpack variables. We have also implemented a data-driven observation operator or the surface data

assimilation to predict the brightness temperatures observed with AMSR2 from the SURFEX land surface model state using a Graph Neural Network method. This prepares the CARRA-Land-Pv2 prototype where MET-Norway and SMHI have coordinated experiments to evaluate the data assimilation system testing and the effect of the assimilation. A candidate configuration for the CARRA-Land-Pv2 demonstrator has been implemented. The CARRA-Land-Pv2 production has been initiated with a spinup run before final evaluations for production readiness.

In parallel we have implemented tested coupling methodologies and strategies in preparation of the configurations of the CARRA3-Pv1 demonstrator. For this we have set up a shared code repository based on the CARRA2 system used for the present C3S Arctic reanalysis production. Here we have implemented unified surface assimilation with the LETKF inline methodology. The coupling methodology developments includes the so-called analyzed forcing option benefitting from time-dense near-surface observations as well as testing assimilation of near surface observations (2m temperature and humidity) in the HARMONIE-AROME upper-air 3D-VAR system. In addition initial tests have been run towards the development of coupled skin temperature assimilation over land and sea ice. In addition to these experiments with 3D-Var assimilation, outer-loop land-atmosphere coupling in a 4D-var framework has been implemented by SMHI. Ongoing efforts investigate what impact the consistent update of the land-atmosphere initial state has on the near surface fields in 4D-var.