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	2022
Project Title:	A large ensemble of climate projections at high resolution
Computer Project Account:	spsebelu
Principal Investigator(s):	Danijel Belušić
Affiliation:	Swedish Meteorological and Hydrological Institute
Name of ECMWF scientist(s) collaborating to the project (if applicable)	n/a
Start date of the project:	1 January 2021
Expected end date:	31 December 2023

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)	60 000 000	380 052	60 000 000	1 441 287
Data storage capacity	(Gbytes)	35 000	-	70 000	-

Summary of project objectives (10 lines max)

The project develops and utilises an on-demand climate downscaling procedure for high-impact weather events using a high-resolution regional climate model (convection permitting regional climate model - CPRCM). The procedure consists of two main steps:
1. detecting potential high-impact events of interest in a parent simulation, typically a global climate model (GCM),
2. using an automated downscaling procedure for extreme events, which includes re-running the parent model to save model levels and running the CPRCM for a large number (hundreds) of detected events.
The goal is to provide a sufficient number of simulations for a robust statistical analysis of extreme events.

Summary of problems encountered (10 lines max)

The main problem that we encountered is that the CPRCM version (HCLIM cycle 43) that is going to be used for the project has been under development and evaluation for a longer time than anticipated. This is dependent on a number of internal and eternal factors, noting that the task of development and evaluation is performed by the international HCLIM consortium. The final tuning and evaluation are being performed and we anticipate the operational version to be available by the end of August 2022, which is when this year's simulations will be initiated.

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

The first extensive simulations will be started in early September. These simulations will downscale ERA5 and serve as an evaluation of the downscaling methodology and the modelling system. These simulations will use the remaining allocated SBU for 2022.
The plan for 2023 has not changed and includes a large number of simulated events in the present and future climate using km-scale simulations with a CPRCM.

List of publications/reports from the project with complete references

The event-based downscaling is based on high-impact event detection from GCMs, which is in turn related to the circulation type classification of GCM ensembles. The following two papers address the circulation type classification methodology and its application to the SMHI Large Ensemble performed with EC-Earth, respectively:

1. Hansen, F., Belušić, D., 2021: Tailoring circulation type classification outcomes. Int. J. Clim., 41, 6145–6161, doi: 10.1002/joc.7171.
2. Hansen, F., Belušić, D., Wyser, K., Koenigk, T., 2022: Future Changes of Circulation Types and Their Effects on Surface Climate in the SMHI Large Ensemble. Clim. Dyn., submitted.

The added value of the convection permitting model HCLIM, which is used in this project, over a Fenno-Scandinavian domain for the present and future climate has been addressed in the following papers:

1. Médus, E., Thomassen, E. D., Belušić, D., Lind, P., Berg, P., Christensen, J. H., Christensen, O. B., Dobler, A., Kjellström, E., Olsson, J., Yang, W., 2022: Characteristics of precipitation extremes over the Nordic region: added value of convection-permitting modeling. Nat. Hazards Earth Syst. Sci., 22, 693–711, doi: 10.5194/nhess-22-693-2022.
2. Lind, P., Belušić, D., Médus, E., et al., 2022: Climate change information over Fenno-Scandinavia produced with a convection-permitting climate model. Clim. Dyn., submitted.

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 planned simulations in the first project year (2021) were delayed until 2022 and the allocated annual SBU's returned. Furthermore, the simulations planned for 2022 will be performed from September to December 2022. Therefore, the main results, which are based on simulations, cannot be reported yet.
However, the improvements of the event-based downscaling chain are actively worked on. The main methodology for detecting high-impact events has been developed and further improvements are under way, as illustrated by the publications listed above and others that are in preparation. The first set of GCM simulations, using the SMHI Large Ensemble performed with EC-Earth, is ready for downscaling with the saved model levels. The selection of these simulations was based on specific warming levels in the present and future climate.
A method for improving and accelerating the spin-up of soil moisture and temperature for CPRCM simulations has been developed. This is crucial for event-based downscaling because the usual procedure in regional climate modelling of running one or more years for spin-up purposes is unfeasible for many single events.