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	2024
Project Title:	RegiOnal climate simUlations over ItaLy: a focus on futurE exTreme weaTher Events (ROULETTE)
Computer Project Account:	spitavol
Principal Investigator(s):	Elenio Avolio
Affiliation:	Institute of Atmospheric Sciences and Climate, National Research Council of Italy (ISAC-CNR)
Name of ECMWF scientist(s) collaborating to the project (if applicable)	……
Start date of the project:	01/01/2023
Expected end date:	31/12/2025

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)	10.000.000	7.000.000	12.000.000	4.056.988 (*)
Data storage capacity	(Gbytes)	30000	1350	30000	15000

(*) due to my misunderstanding, I also used 6.526.638 (from another account) in addition to 4.056.988 of my special project. Thus, a total of 10.583.626 was used.

Summary of project objectives (10 lines max)

The main objective of the project is to build a high-resolution database of present and future climate simulations, mainly devoted to the extreme weather events studies (flash floods, tornadoes, Mediterranean cyclones, heat waves, dust intrusions, etc.). Twenty years of simulations will be considered for both the current climate and for the future climate; for the latter, two scenarios will be taken into account.

Summary of problems encountered (10 lines max)

No particular problems occurred, but little changes were made to some initial run strategy decisions. In the first phases of the project, I identified, as possible GCM model from CMIP6, the EC-Earth model (0.7° resolution). During the activity development, I decided to adopt a more robust dataset for the initial and boundary conditions for the downscaling: a bias-corrected global dataset based on 18 models from the CMIP6 and the European Centre for Medium-Range Weather Forecasts Reanalysis 5 (ERA5) dataset.

An issue has been related to my misunderstanding about the available computing facilities. Having another (default) account at ECMWF, I used the SBUs of this account for a certain period. I want to underline this aspect because it might seem that the availability of SBUs granted to me is overestimated. But it isn't and, indeed, the resources at my disposal might be insufficient to complete all the activities.

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

The project will continue according to the pre-established plans, continuing the simulations with the WRF regional model for the present climate and for the future climate. The ERA5 fields are used as forcing for the “present climate” runs. Two scenarios of the considered CMIP6 dataset are considered for the “future climate” runs.

With respect to the assumption of the first year, I decided of running all runs simultaneously (both present and future runs), in order to make best use of the provided computational resources.

List of publications/reports from the project with complete references

There are no publications from the project so far.

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.

I understand that the guidelines for drafting this section would require, for the second year, a substantial report with adequate descriptions of the obtained results. While I agree this approach, I cannot completely satisfy this rule, due to the peculiarity of my research project.
My project idea, in fact, requires the massive execution of numerical simulations of a high number of years (60), both for the downscaling of the present climate and for that of the future climate. For this reason, only after the execution of all runs, I will be able to obtain quantitative results and comment on them.

In this intermediate phase of the activities, I can summarize the main objectives of the project and provide an update about the status of the ongoing simulations.
In my case, I think that the length of the report cannot reflect the complexity and duration of the project.

The very first phases of the project were about the installation of a stable version of the model, as well as the definition of the computational grids. In figure 1 is reported the adopted numerical domains.

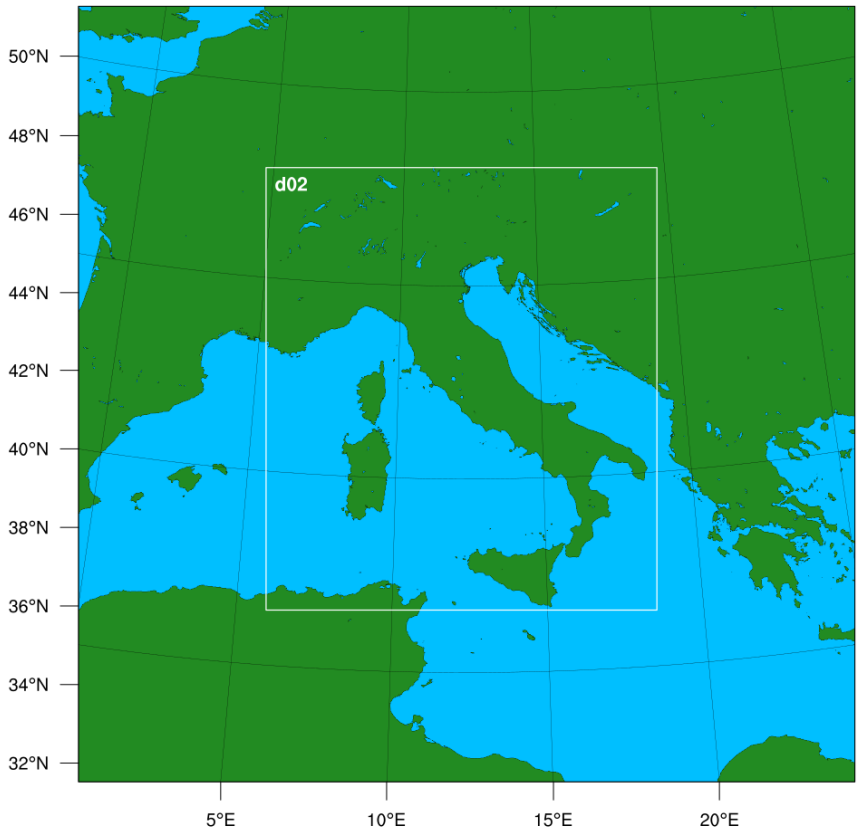

Figure 1. WRF domains.

As we can see the whole Italian territory is considered in the nested grid.

The WRF model was configured to simulate the climate in Italy with a horizontal resolution grid of 3 km (Figure 1). An intermediate grid at 15 km resolution was configured as parent domain (a resolution comparable with other RCMs, e.g. euro-cordex initiatives). 50 vertical levels are adopted, with the vertical coordinates that follow the terrain.

In the first 6 months of the project (from January 2023 up to June 2023) most of the work consisted in identifying the best configurations for the WRF regional model. After a few preliminary tests, the parameterization schemes considered most suitable for the long-term simulations were identified. Further tests were carried out for the optimal choice of the number of processors to use (scalability).

The parameterization schemes for microphysics, convection, radiation and turbulent processes will be activated. Model outputs will have 3-hourly temporal resolution for the parent domain, and 1-hourly resolution for the high-resolution domain.

The large-scale fields for the IC/BC conditions are progressively downloaded, as the simulations proceed, both for the present climate downscaling (ERA5 fields) and for the future scenario simulations (bias corrected CMPI6 fields).

Twenty years of simulations are considered for the current climate (2001-2020), and twenty years for the future climate (2081-2100). For the latter, two scenarios are considered, namely SSP245, that represents a moderate socioeconomic-development path with medium-low radiation forcing, and SSP585, that represents the combined scenario of a high energy-intensive, socioeconomic developmental path with strong radiative forcing.

Unlike what was initially planned, it was decided to run the simulations (present, future scenario 1, future scenario 2) simultaneously, to better use the computational resources.

This is a summary of the simulations completed so far:

- Present: 2001-2004
- Future scenario SSP585: 2081-2084
- Future scenario SSP245: 2081-2084

(For each series, 6 months of simulations were done, considered as spin-up).

A total of 12 years was concluded, out of 60 years expected. Therefore, just under 25% of the total number of runs was achieved.

As said before, each run cover one month, and the duration of each simulation is about 30-36 hours, using 120 processors.

A large amount of time is spent moving/organizing data. Unfortunately, it will not be possible to archive the entire output of the runs (which we are doing right now, but which we will have to stop in the next future), due to their huge size. In fact, a single year's run takes up around 2.1 TB of disk space.

To cope with this, a post-processing procedure is carrying out, to extract and archive only a subset of the parameters produced by the simulations, i.e. those considered most useful for the analyses that will be carried out in the final phases of the project.