SPECIAL PROJECT FINAL REPORT

All the following mandatory information needs to be provided.

Project Title:	WRF-based high resolution numerical weather simulations to complete the extension of the new Italian Wind Atlas
Computer Project Account:	spitsper
Start Year - End Year :	2025 - 2025
Principal Investigator(s)	Simone Sperati
Affiliation/Address:	Ricerca sul Sistema Energetico (RSE) SpA
Other Researchers (Name/Affiliation):	Riccardo Bonanno (RSE SpA)

The following should cover the entire project duration.

Summary of project objectives

(10 lines max)

The aim of the project was to continue the extension of the dynamically downscaled 5-year period of the new Italian Wind Atlas AEOLIAN up to 2024 using the WRF model. The extension by dynamical downscaling of the ERA5 global fields allows capturing the atmospheric dynamics, benefiting of the availability of 10-m wind measurements by the Italian regional weather services.

Summary of problems encountered

(If you encountered any problems of a more technical nature, please describe them here.)

No problems were encountered during the project.

Experience with the Special Project framework

(Please let us know about your experience with administrative aspects like the application procedure, progress reporting etc.)

The application procedure went smooth and allowed us to quickly benefit of the ECMWF computational resources. The ECMWF AC cluster is reliable and fast. Compilation of codes (e.g., WRF v3.9) went also smooth.

Summary of results

(This section should comprise up to 10 pages, reflecting the complexity and duration of the project, and can be replaced by a short summary plus an existing scientific report on the project.)

This activity is the continuation of the special project SPIPTSPER 2024, in which the Italian Wind Atlas AEOLIAN [1] was extended beyond 2019 to the years 2020 and 2021, in order to cover the most recent years and have an updated description of the wind conditions over Italy. Unlike the extension in the past (i.e., prior to 2015), for which the Analog Ensemble (AnEn) technique described in [1][3] was used, also in this case it was chosen to continue the numerical simulations with the WRF model [3] as already done for the period 2015-2021. In this way, it is possible to benefit from assimilating in the simulations the observation stations available, as well as the entire set of meteorological variables output from the model, possibly usable for other purposes. The current project allowed further extending AEOLIAN up to 2024, with the result of completing a 10-year numerical simulation archive.
Figure 1 shows the computational domain of the numerical simulations conducted with WRF, with a 1.33 km grid centered on Italy nested into a coarser, 4-km grid. The external and internal grids are made up of 520x520 and 837x1029 grid points respectively, and the internal one constitutes the area covered by AEOLIAN. The temporal resolution is equal to 1 h.

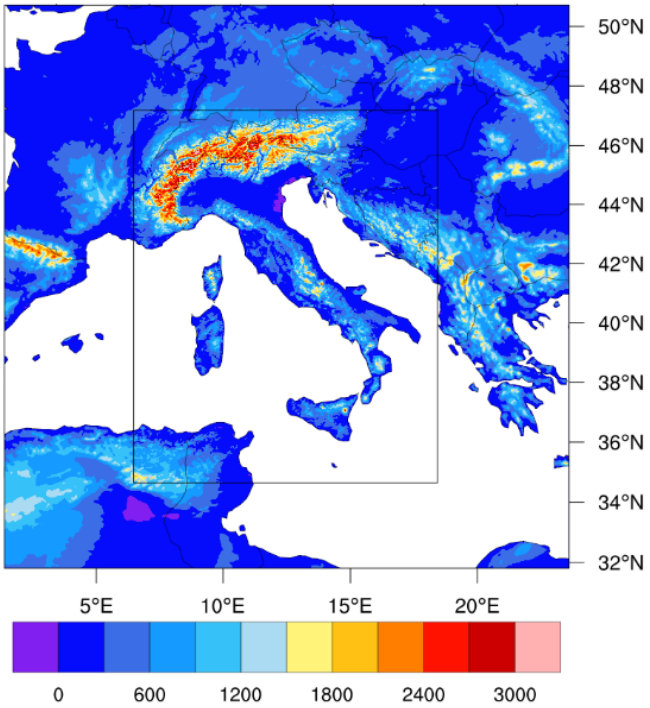

Figure 1 Computational domain of the WRF simulations.

This late special project request of 45 million core hours allowed simulating the years 2022-2024, maintaining the same WRF configuration already used. Following the simulations, comparisons were conducted to verify any deviations in the average wind fields. Specifically, the average wind at 100 m of the period 2015-2019 was compared with that of the period 2015-2024, obtaining the map of the differences reported in Figure 2.

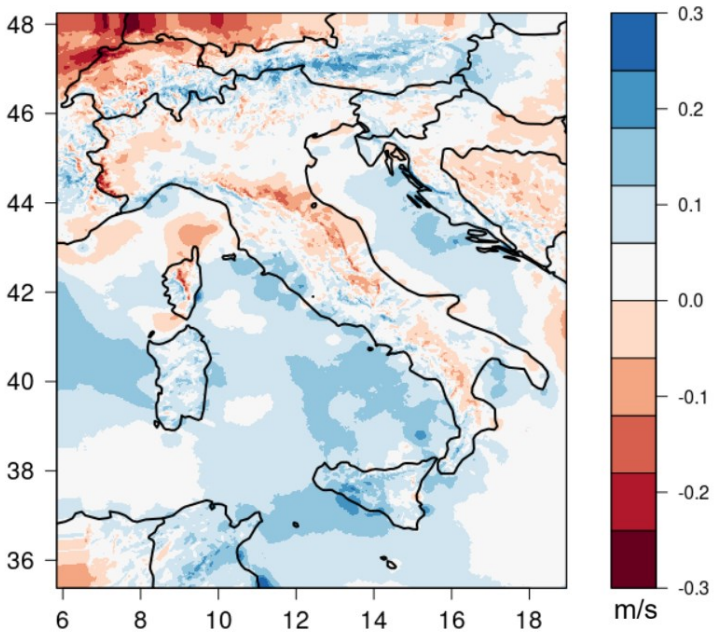

Figure 2 Map of differences (in m/s) between the average of the period 2015-2019 and the average of the period 2015-2024 at 100 m.

The map generally highlights a slight positive deviation in the Alpine areas, on the major islands and marine areas and the Tyrrhenian coast, where the average calculated over 10 years is slightly lower than that calculated over 5 years, and negative along the Apennine ridge, much of Tuscany, on Corsica, in the Ligurian Sea and over western Piedmont, indicating slightly higher values in the period 2020-2024, which they therefore influenced the average. In any case, it should be noted that the deviations are limited at 0.3 m/s in both directions.

1. Sperati S, Alessandrini S, D'Amico F, et al. A new Wind Atlas to support the expansion of the Italian wind power fleet. Wind Energy. 2024; 27(3): 298-316. doi:10.1002/we.2890.
2. Delle Monache, L., Eckel, F.A., Rife, D.L., Nagarajan, B., Searight, K. Probabilistic weather prediction with an analog ensemble. Mon Weather Rev. 2013;141(10):3498-3516. doi:10.1175/mwr-d-12-00281.1
3. Skamarock, W., Klemp, J., Dudhia, J. A description of the Advanced Research WRF Version 3. Tech. Note NCAR/;475;2008.

List of publications/reports from the project with complete references

Sperati S.; Perona, D.; Ronzio, D.; Bonanno, R. Studi ed elaborazioni per la caratterizzazione delle risorse eolica e solare e analisi di indicatori di siccità energetica. 2025. RSE technical report, 25009761, Milano (IT).

Future plans

(Please let us know of any imminent plans regarding a continuation of this research activity, in particular if they are linked to another/new Special Project.)

Future plans regard the possible extension of the dataset ahead of 2024, to update the atlas with the most recent years with the same dynamical downscaling approach already used, based on specific needs and activities for which recent high-resolution wind fields are required.