

REQUEST FOR A SPECIAL PROJECT 2023–2025

MEMBER STATE: ITALY

Principal Investigator¹: Luciana Bertotti

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Other researchers:

Luigi Cavaleri

Project Title: **The role of orography and model resolution in the underestimate of modelled offshore blowing winds**

If this is a continuation of an existing project, please state the computer project account assigned previously.	SP SPITWM	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2023	
Would you accept support for 1 year only, if necessary?	YES <input checked="" type="checkbox"/>	NO

Computer resources required for 2023-2025: (To make changes to an existing project please submit an amended version of the original form.)	2023	2024	2025
High Performance Computing Facility (SBU)	600000	600000	600000
Accumulated data storage (total archive volume) ² (GB)	200	200	200

Continue overleaf

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.

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Extended abstract

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

1 – The previous results

This line of research arose from some preliminary results by Luciana Bertotti and Luigi Cavaleri who had obtained undeniable evidence that in their daily wave forecast in the Adriatic Sea (East of Italy) the speed of the ECMWF wind fields had to be regularly increased to match the scatterometer measured values and consequently to get the correct modelled wave heights. This turned out to be a regular feature of all the coastal winds (when blowing to offshore) and it led to the previous Special Project where a number of interesting results emerged. For instance it was soon clear, as progressively confirmed along the successive increases of resolution of the ECMWF high resolution meteorological model. Indeed in the years the required “enhancement” factor decreased from 1.50 (with T213) to 1.35 (T511), 1.27 (T799), 1.21 (T1279), 1.16 (Tco1279).

These practical results led to the present Special Project SPITWM (“Underestimate of modelled offshore blowing winds”) that, while quantifying more precisely the problem, opened at the same time new lines of research. For instance (see Figure 1) it is clear that the underestimate and the length of sea (we define it as “fetch”) required for the model winds to reach the “correct” values is wind speed dependent. One of the most interesting results is that the required fetch length strongly depends on resolution. More so, it can be scaled with resolution. This is clearly shown in Figure 2.

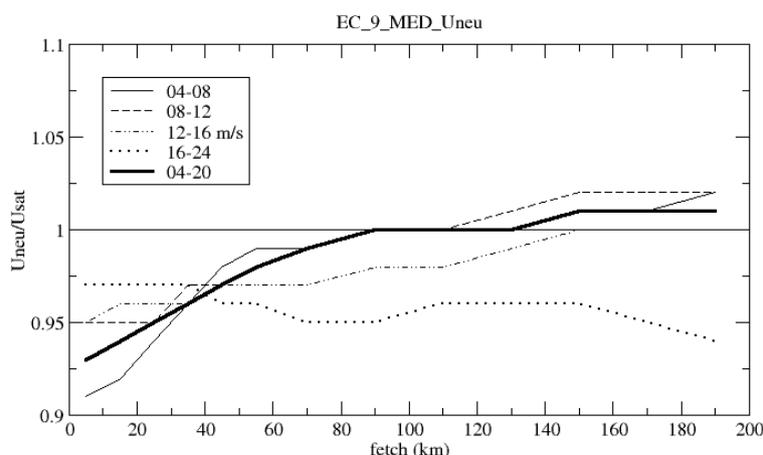


Figure 1 – Ratio between model neutral and scatterometer wind speed values as a function of fetch (km) and of the wind speed at the measurement point. The dark line is the average of all the data.

2 – The role of orography

The practical experience of the last 30 years indicates beyond any doubt that an increase of resolution leads to higher wind speeds, both offshore and at the coast. However, some results obtained by the visiting scientist Takafumi Kanehama (2022) clearly indicate that a higher resolution (hence a more “complicated” orography) leads to lower coastal wind speeds. Obviously, this contrasts with the previous results and the practical experience of the last 30 years (see Section 1). There are clearly two contrasting effects, and this is where we plan to focus our attention.

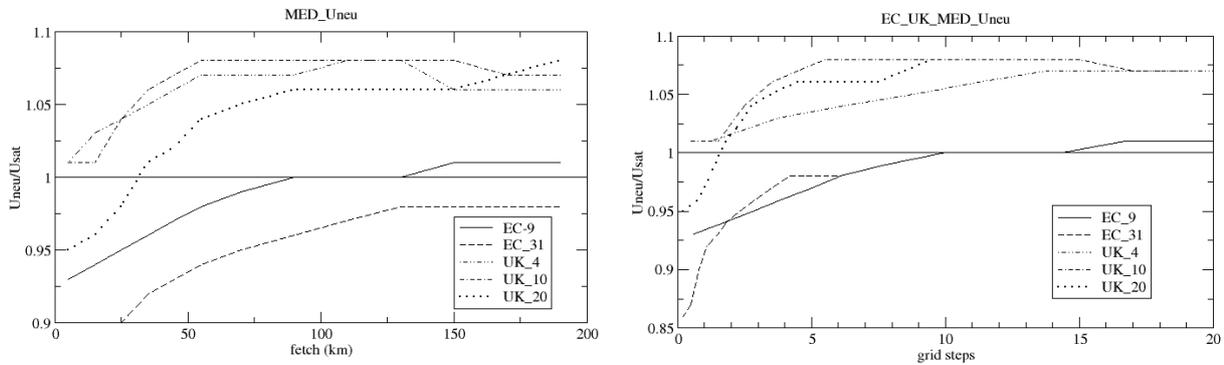


Figure 2 – Left panel: the by now classical model underestimate with respect to scatterometer data, with an asymptotic behavior with fetch. Clearly the results differ with resolution. In the right panel the horizontal dimension is scaled according to each model resolution. For each (ECMWF or UKMO) model this leads to a substantial convergence of the various curves.

3 – Actions to be taken

- a) We focus on two specific periods when suitable data are available. The first one is January 2015 for which different orographic resolutions have been used while running the meteorological model at the present Tco1279 resolution.
- b) We have already done and almost completed a detailed analysis of the three months October-December 2018 in the Mediterranean Sea. These will be reviewed from the new perspective of the role of orography in establishing the wind coastal values. A quantification of the detailed orographic drag will be derived.
- c) A number of experiments with different orography resolutions have been done for the three days 29-31 October 2018 during which the so-called Vaia (or else Adrian) storm hit southern Europe with devastating effects on the sea and the Eastern Alps (Dolomites).

Our plan is to analyse all these periods and events with focus on the coastal winds and the related role of orography.

We consider the possibility of analysing special periods with higher spectral resolutions and various orographic resolutions. The aim is to frame completely the problem producing practical rules and definitions for daily applications.

References

- Cavaleri, L., and L.Bertotti, 2006. The improvement of modelled wind and wave fields with increasing resolution, *Ocean Eng.*, Vol.33, 5-6, pp.553-565-
- Kanehama, T. et al. 2022. Evaluation and optimization of orographic drag in the IFS, ECMWF, TM 893.