How MPAS Can Make Wind Resource Modeling Really Seamless

Marta Gil Bardají
Vortex FdC

Abstract

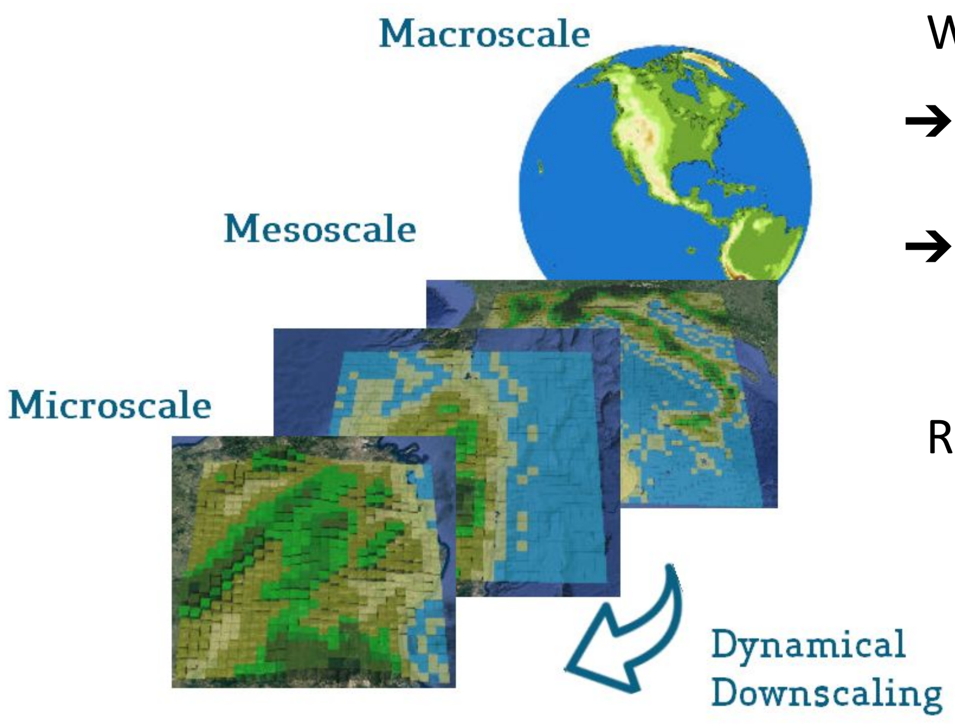
A different perspective to improve the modeling chain has been opened by a new modeling framework which is intended to replace the Weather Research and Forecasting (WRF) system in the mid-term. This perspective brings a new approach to revisit the global and mesoscale modeling inter connection and to build a fully seamless atmospheric downscaling modeling solution named Model for Prediction Across Scales (MPAS).

The present study shows the first analysis of MPAS suitability for wind resource assessment applications and, in the context of an early development stage, offers encouraging results from MPAS when compared to WRF.

Objectives

- Meet a new mesoscale model frame: MPAS.
- Compare data from wind measurements with WRF and MPAS simulations.
- Understand which development and improvements of the model would benefit wind resource assessment.

Introduction to MPAS



Wind Industry has benefited from:

- ➔ Better macroscale input data (reanalysis like ERA5)
- ➔ Better microscale models (like WRF-LES)

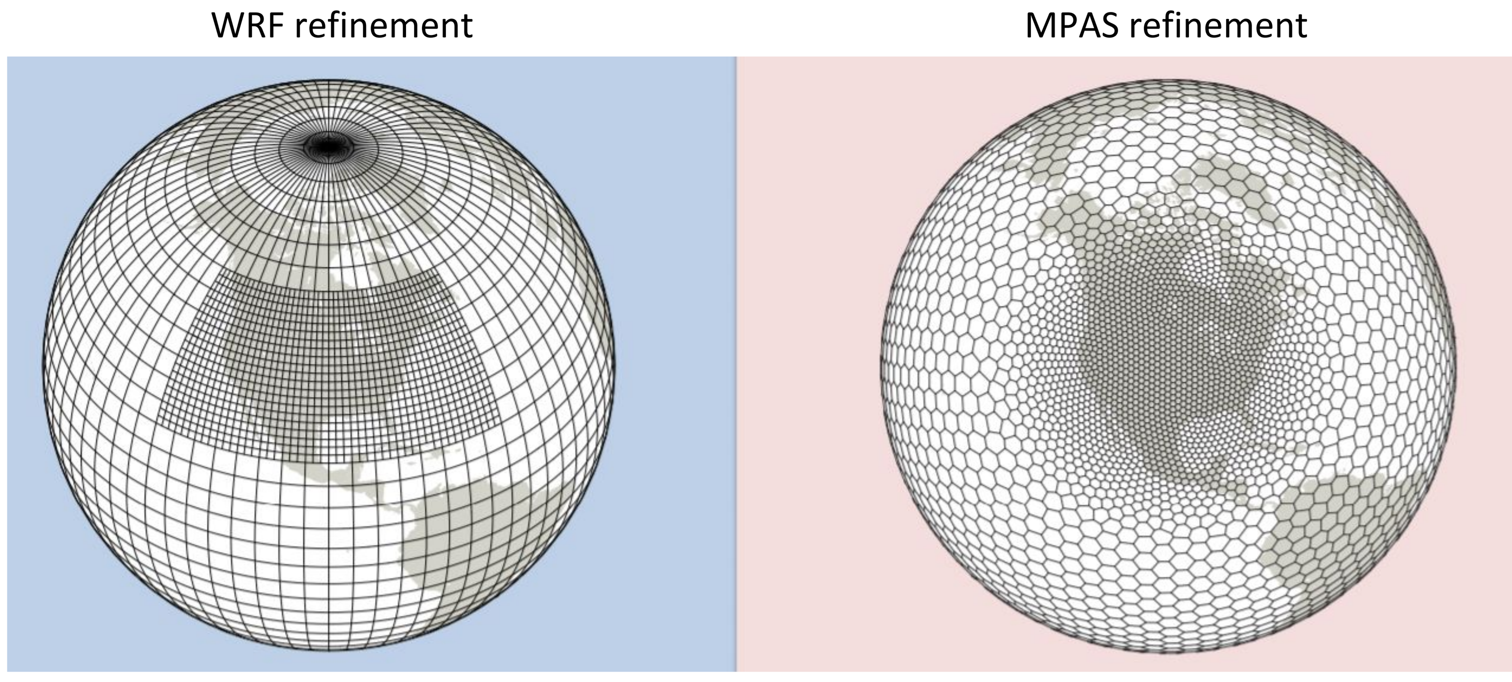
Reference downscaling tool: WRF

Is it time to change the downscaling method itself?

"The Model for Prediction Across Scales (MPAS) is a collaborative project for developing atmosphere, ocean and other earth-system simulation components for use in climate, regional climate and weather studies." *(https://mpas-dev.github.io/)*

MPAS meshes are unstructured 2D horizontal grids called **Spherical Centroidal Voronoi Tesselations**, generated by an iterative process (Lloyd's method) to generate an approximated valid mesh from a user-defined density function. Regions can be cut from the global meshes.

- ➔ Seamless interaction between scales
- ➔ No flow distortions at nest boundaries
- ➔ No deformation due to projections
- ➔ Can be run in parallel computers



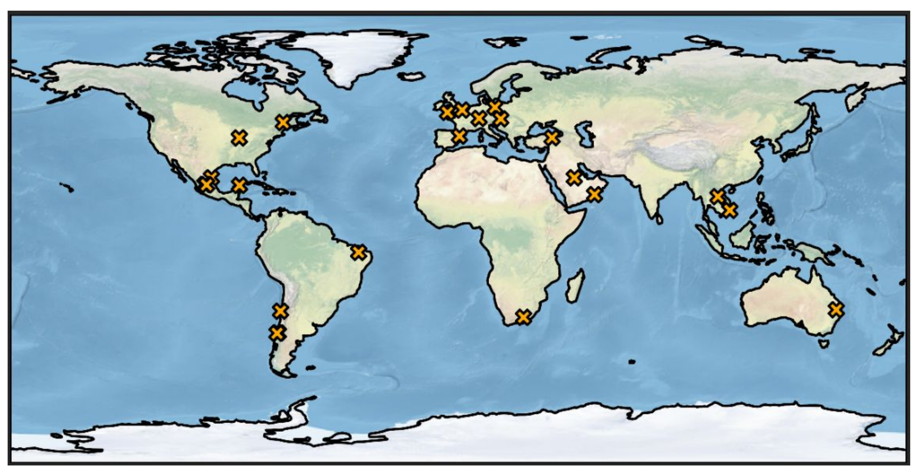
Wind Resource Assesment in MPAS

To obtain long term wind data time series at specific locations or small regions the required mesh would have a smooth transition from the central resolution (high) to low resolution (reanalysis) and contain the smallest possible number of cells to reduce computation cost and time.

- ➔ We are not there yet. MPAS does not release a mesh generation tool and the variable resolution meshes available for download are huge.
- ➔ The simulations in this study will use the available quasi-uniform meshes (10 and 15 km resolution).

Method

23 sites. 1 year wind data. 4 simulations using ERA5 reanalysis:



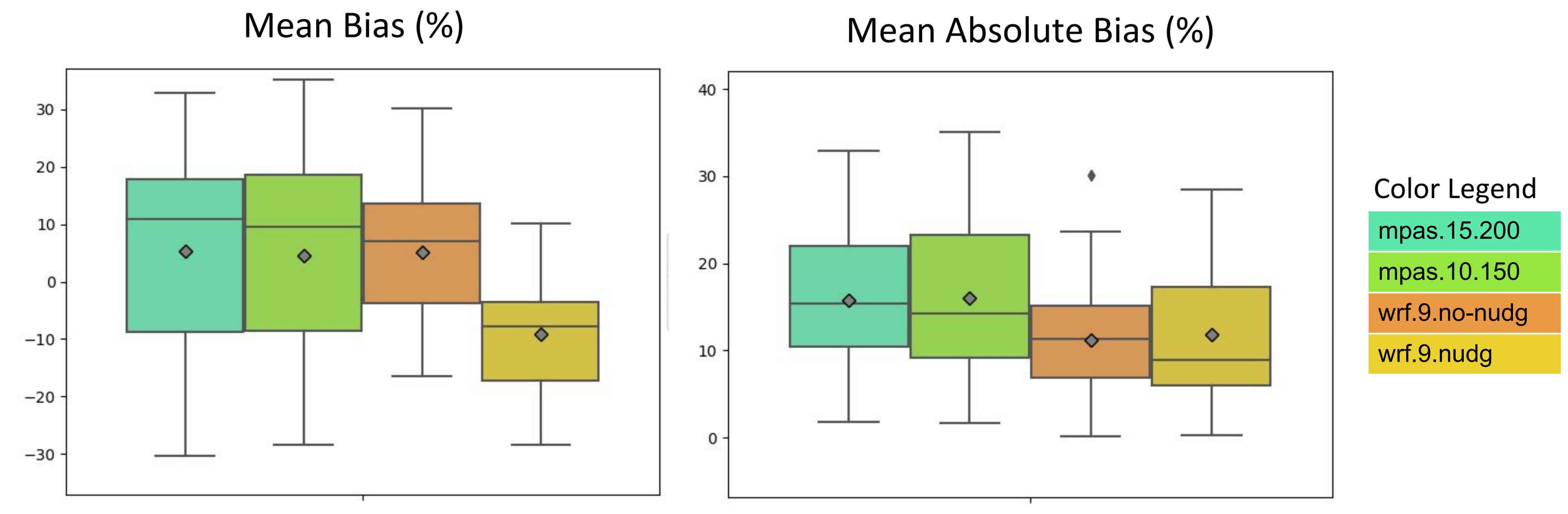
MPAS	mpas.15.200	mpas.10.150
resolution	15 km	10 km
radius	200 km	150 km

WRF	wrf.9.no-nudg	wrf.9.nudg
resolution	9 km	9 km
nudging*	no	yes

* nudging: Option available in WRF to control the simulation using reanalysis values

Results

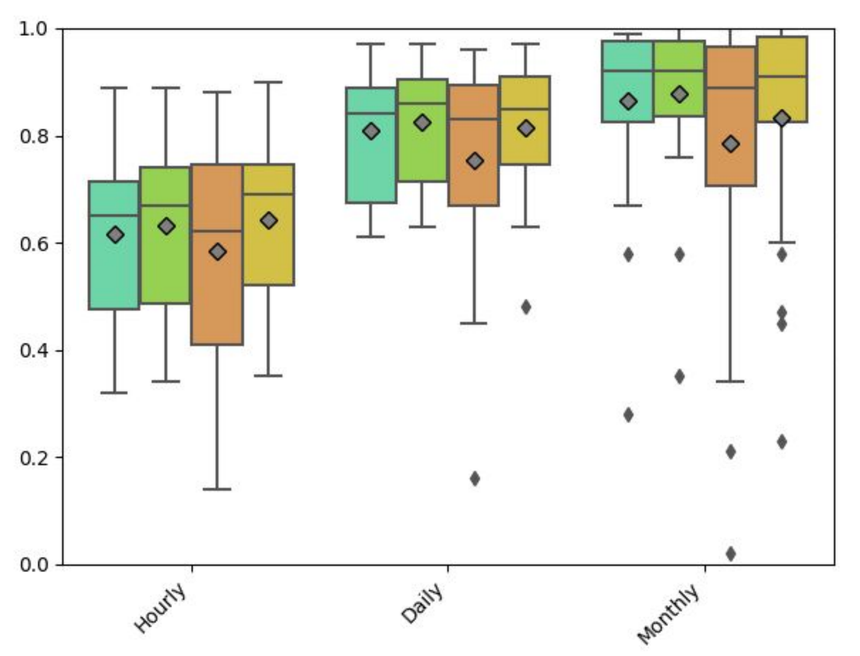
Mean wind speed bias and absolute bias (in %)

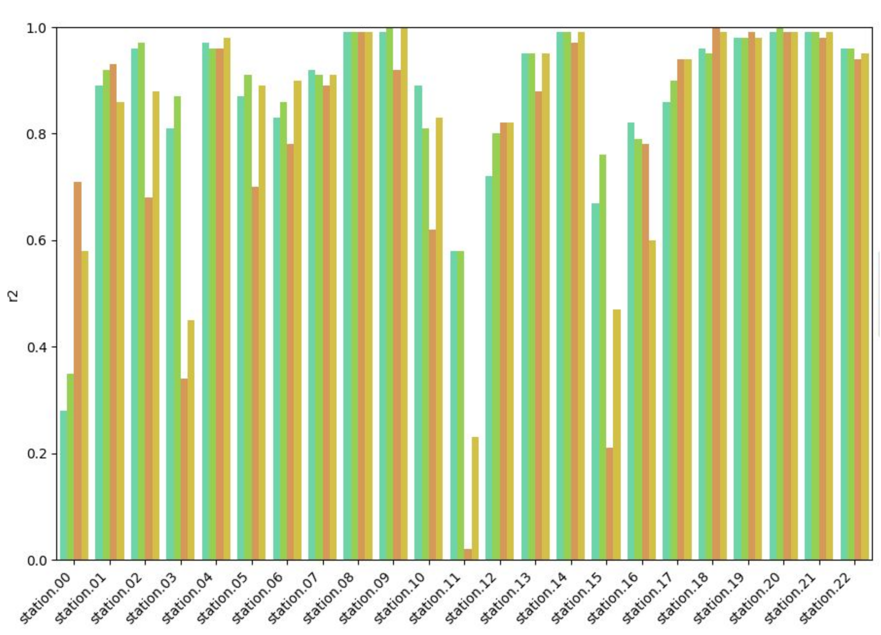


- ➔ High bias are expected due to resolution
- ➔ MPAS results are spread wider than WRF and very similar for both simulations

	Mean bias (%)	Mean absolute bias (%)
mpas.15.200	5.36 ± 17.50	15.78 ± 8.70
mpas.10.150	4.55 ± 18.28	16.07 ± 9.26
wrf.9.no-nudg	5.08 ± 12.52	11.16 ± 7.32
wrf.9.nudg	-9.07 ± 11.09	11.77 ± 8.01

Hourly, daily and monthly correlation





- ➔ Both MPAS simulations (without nudging) correlate better than WRF simulations. Especially monthly.

	Hourly	Daily	Monthly
mpas.15.200	.62 ± .16	.81 ± .11	**.86 ± .17**
mpas.10.150	.63 ± .16	.82 ± .10	**.88 ± .15**
wrf.9.no-nudg	.58 ± .21	.75 ± .20	.78 ± .27
wrf.9.nudg	.64 ± .16	.82 ± .12	.83 ± .21

Computation

Simulations run using 1 core and split in days (considering 6h of spinup, it means 30h simulations)

- ➔ Using one core MPAS does not go faster than WRF.

	Grid preparation time (min)	Average simulation 30h time (min)
mpas.15.200	30	15
mpas.10.150	40	18
wrf.9.no-nudg	0.5	12
wrf.9.nudg	0.5	12

Conclusions

Some interesting ideas:

- As soon as there is a mesh generation tool, meshes optimized for the wind industry community can be created and tested.
- Excellent monthly correlations: does MPAS grid structure capture the long term and large scale characteristics better?
- Parallel computing may be the key to run longer and more demanding simulations

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 828799

Download the poster