Wind resource grand challenges: Integration of model and measurements The Gulf of Suez case study

Søren Krohn, Soren Krohn Consulting,
Oriol Lacave & Gil Lizcano, Vortex

Soren Krohn Consulting VORTEX

Agenda

- Wind Resource Grand Challenges
- Gulf of Suez Experiment: Model & Data
- Results
- Outcomes & Comments

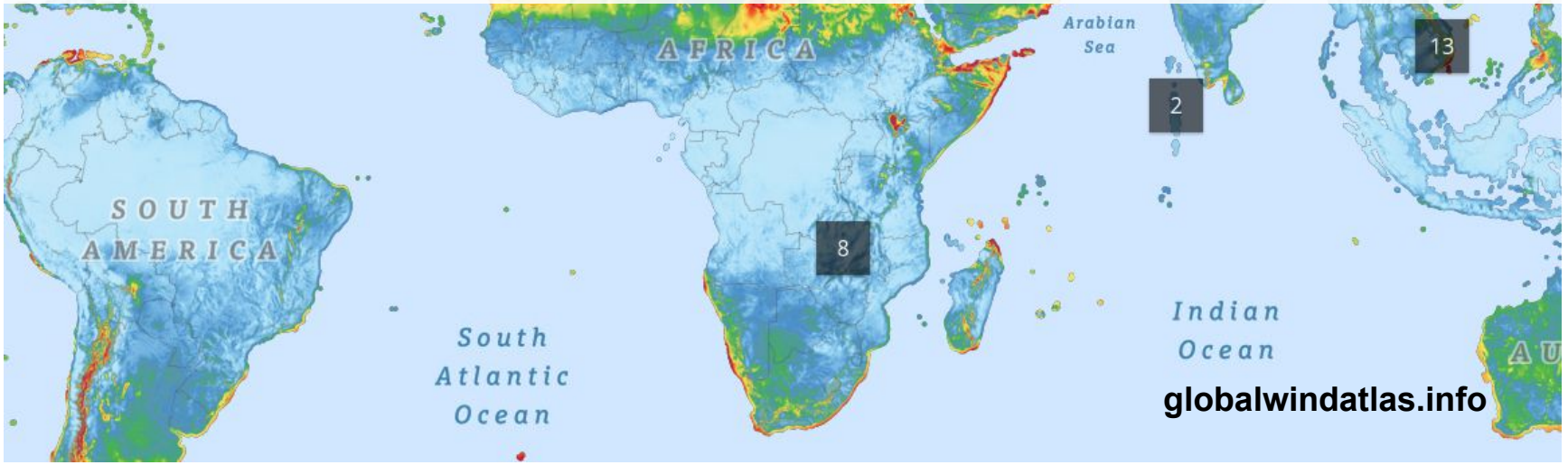
Wind Resource Grand Challenges

Planet Wind: a diversity of wind flow conditions

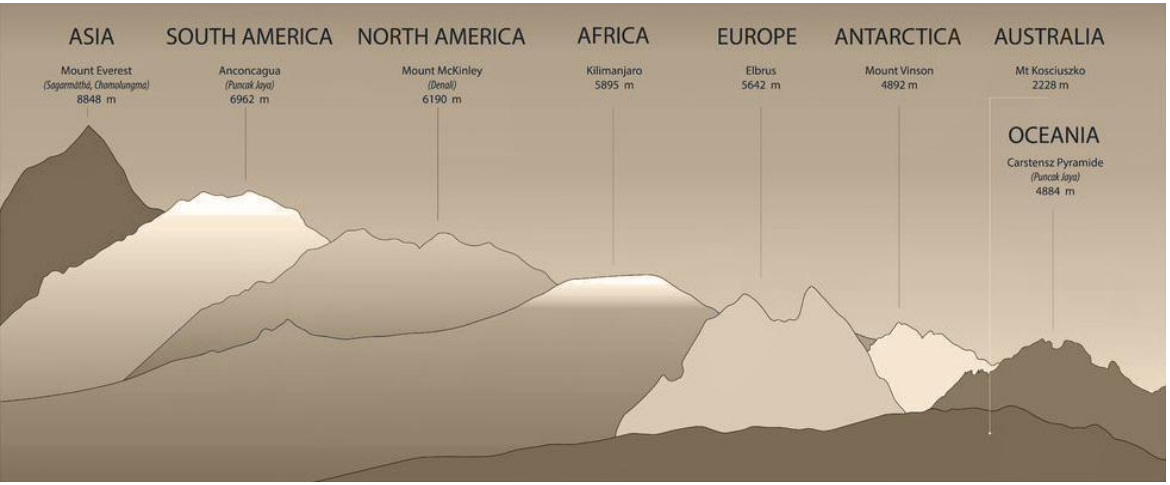
Wind Resource **complexity** is more than a "slope of the terrain" issue

It is a multi-scale problem

Global to local initiative: **GWA 2.0** -> Mesoscale (Vortex) & Microscale (DTU)



Gulf of Suez Experiment

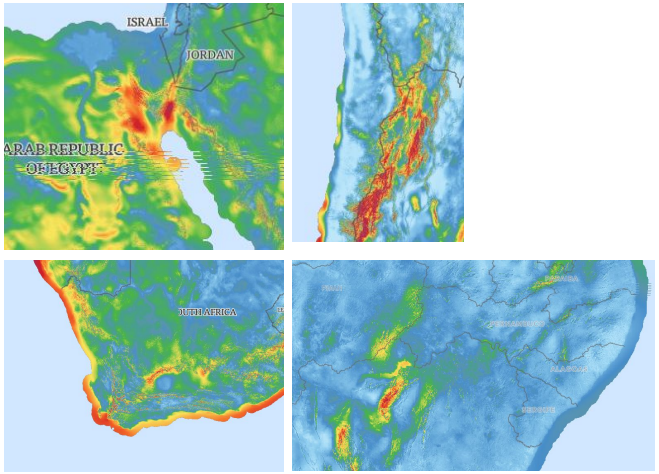


Wind Regime Laboratories

QUESTION:

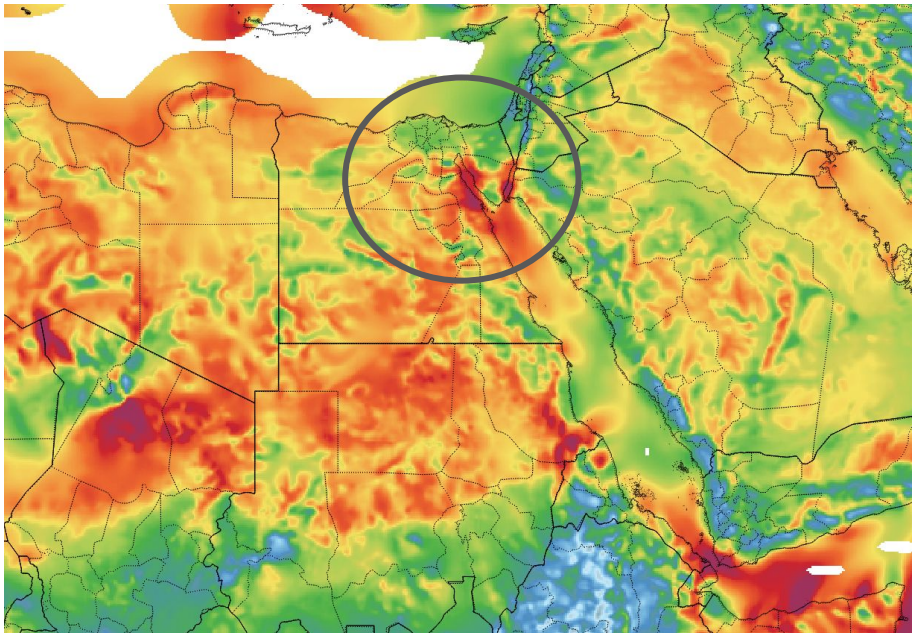
Why are multiscale models more than X m/s off from the observations?

- Gulf of Suez:
  - Strong winds
  - Arid conditions
  - channel effects
  - Complex synoptic frame
  - Sea-land interaction …
- North of Chile
- South Africa / Gouda Site
- North East of Brazil / Innerlands



2 years of measurements
9.88m/s, 773 W/m^2 @ 80m
+ 4 more 80m masts, 1 year of measurments

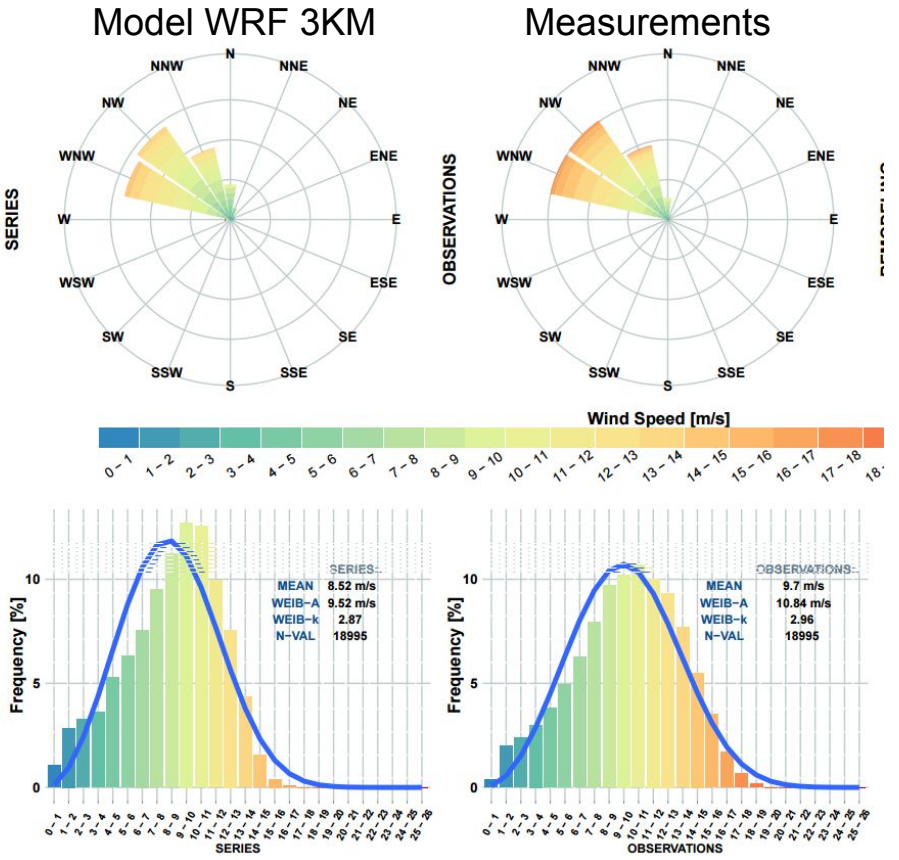
Wind Resource Grand Challenges



Source: WB GWA 2.0 Mesolayer (WRF 9 km res)

➔ **Scale Issue**: Models tends to underpredict wind conditions by more than 15%

➔ k-shape & wind rose are really well represented



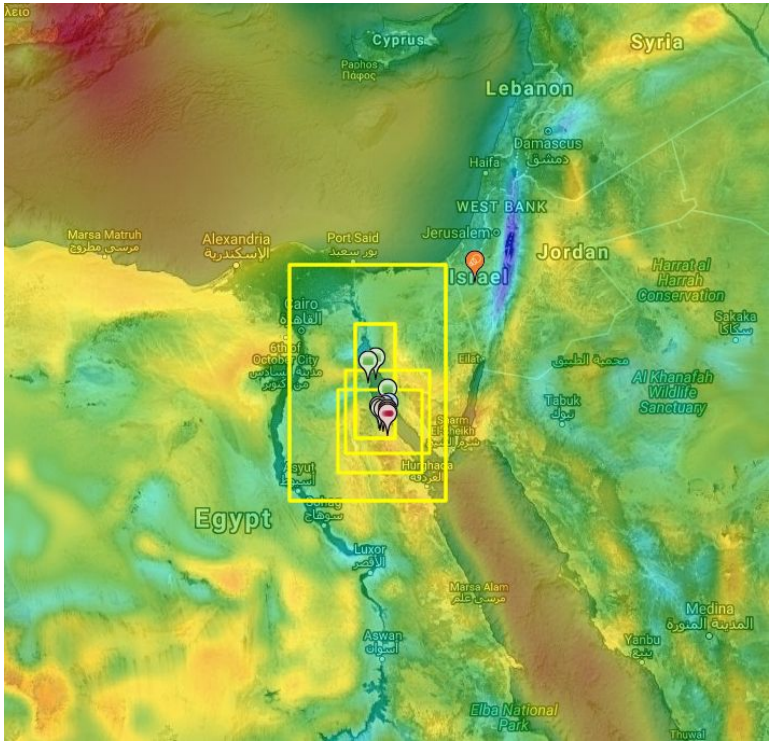
Model & Data

A set of different resolution & domain **WRF** mesoscale model runs have been computed

We explored:

- ★ **Resolution**
- ★ **Domain**
- ★ **Drivers**

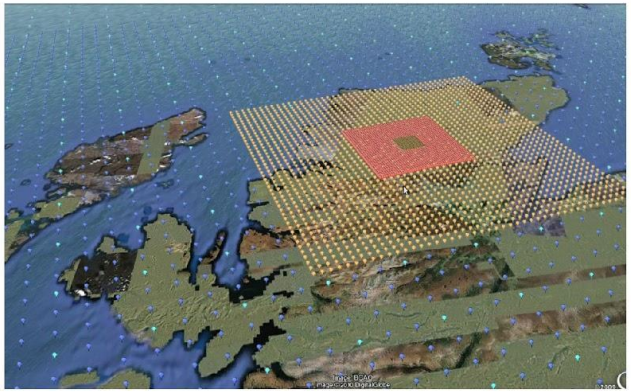
Domain	Resolution	Period	Output	Driver
Regional	3Km	LT	Wind Resource Grid	CFSR ERA5
Regional	1Km	LT	Wind Resource Grid	CFSR ERA5
Project	500m	LT	Wind Resource Grid	ERA5
Project	100m	MP	Time SERIES (LES)	ERA5
Project	3Km	LT	Time Series	ERA5



LT=Long-term
MP= concurrent with available measurements

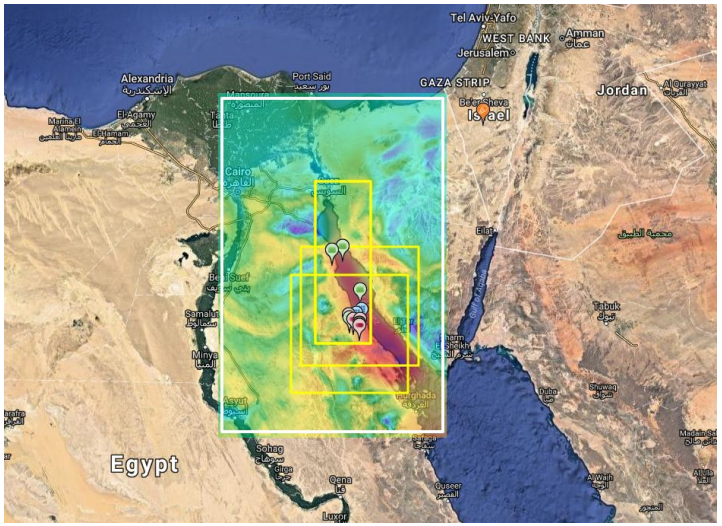
Model & Data

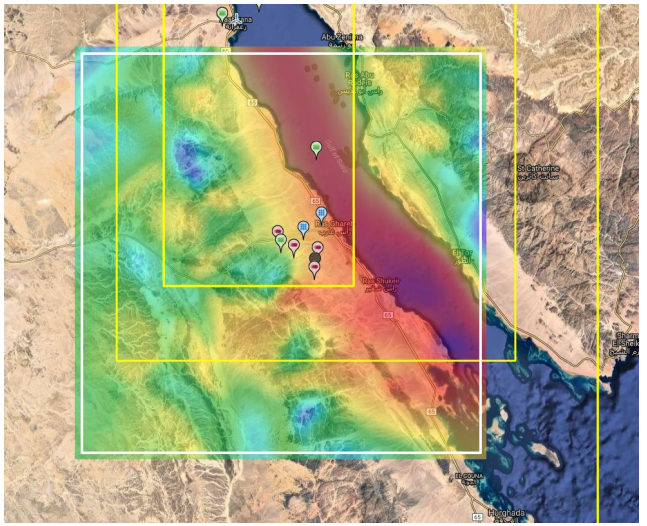
REANALYSIS	MERRA	ERA-Interim	CFS-CFSR	MERRA2	ERA5
Generation	Third			3.5 *	Fourth
Resolution	Hourly / 0.5° x 0.667° 72 levels	4xday 0.75° x0.75° 72 levels	Hourly 0.5°x 0.5° 64 level	Hourly 0.5° x 0.667° 72 levels	Hourly 30Km (/2) 137 levels (X2)
Latency (weeks)	4	12	1	2	
User Notes	Overall good correlation	Arrived late *	Inconsistent SFC but Consistent 3D fields	Aerosol Assimilation	Deterministic & Ensemble (10 members)



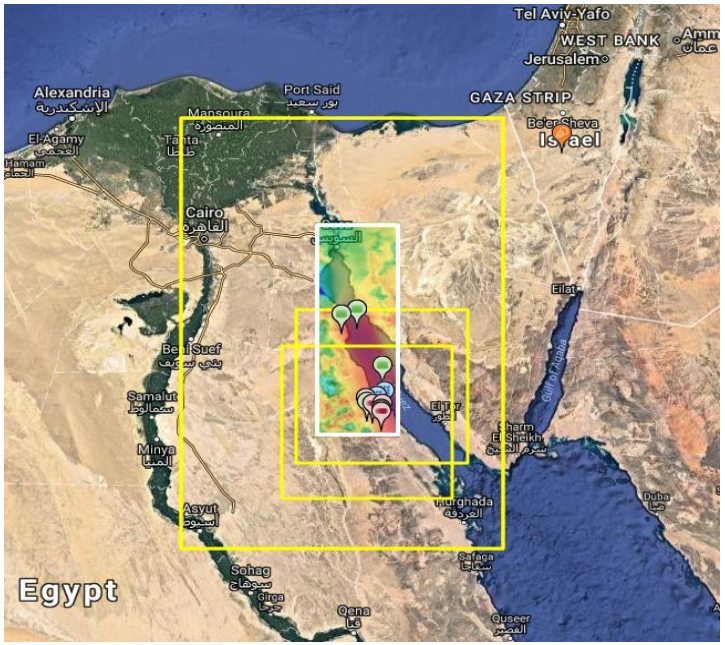
Model & Data

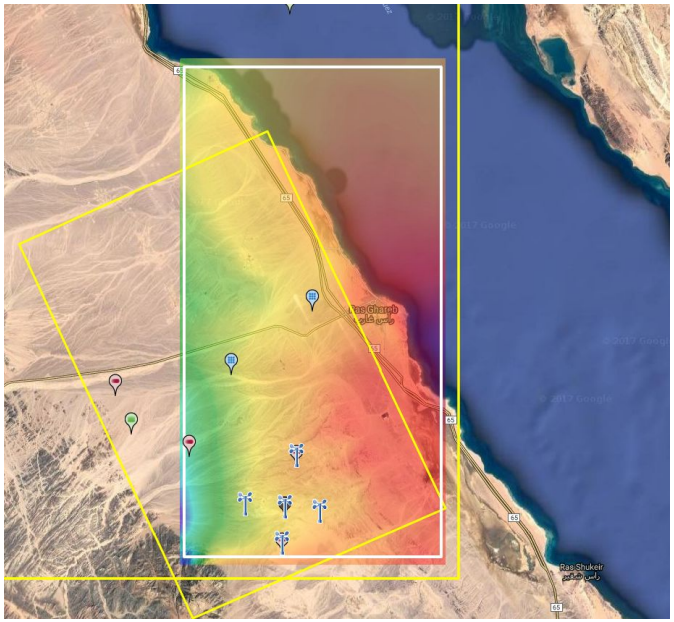
3KM





1KM

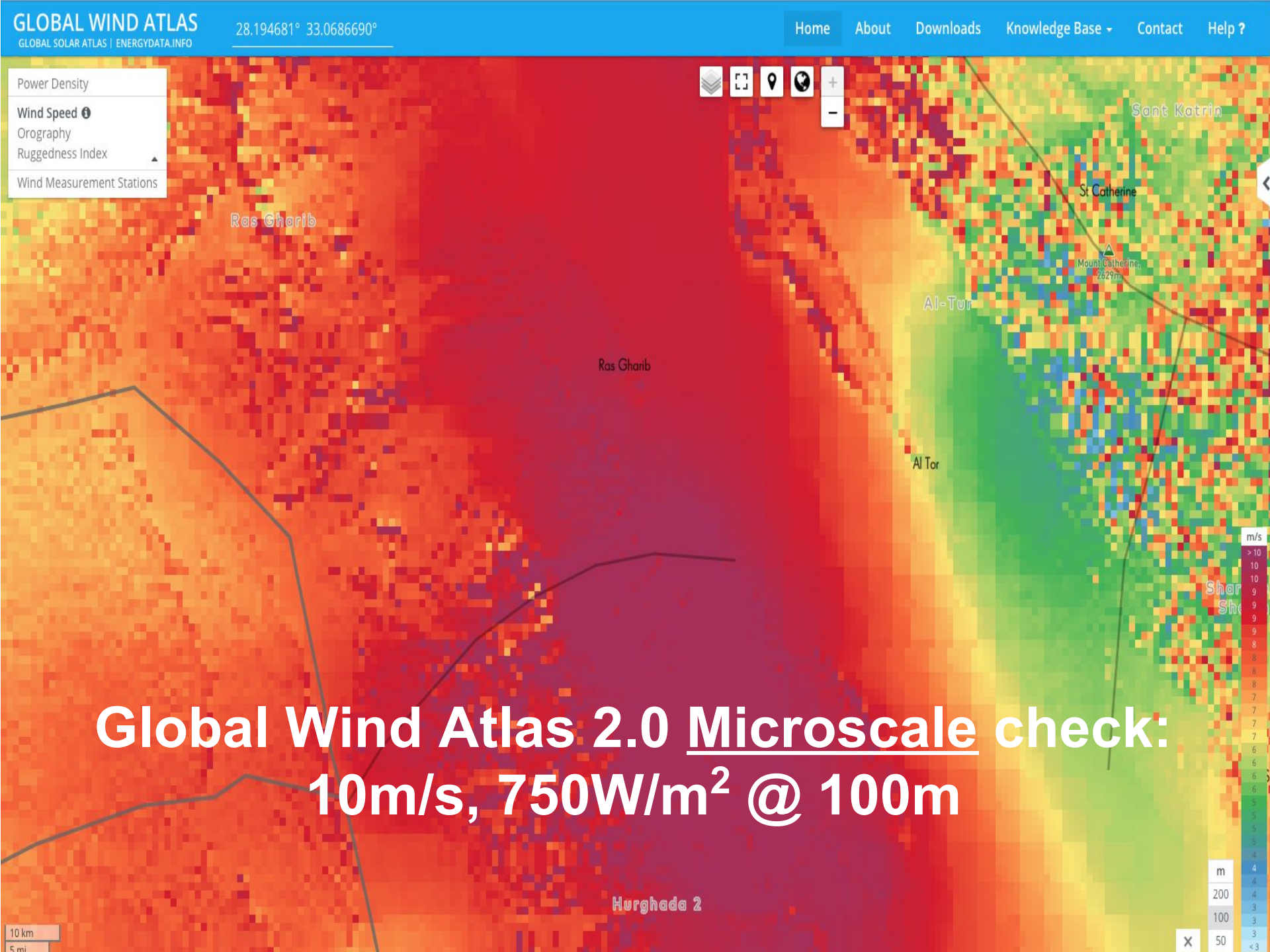




500 m

Results: mesoscale model

Validation					Mean bias		
Domain	Resolution	Period	Output	Driver	Mean Speed	k-shape	Power Density
Regional	9Km	LT	Wind Resource Grid	ERA-Interim	-17.53%	-5.41%	-42.03%
Regional	3Km	LT	Wind Resource Grid	CFSR ERA5	-12.37% -7.22%	-3.04% -2.36%	-31.50% -19.02%
Regional	1Km	LT	Wind Resource Grid	CFSR ERA5	-17.53% -5.15%	-5.07% -3.04%	-42.16% -13.15%
Project	500m	LT	Wind Resource Grid	ERA5	-4.12%	-1.69%	-11.00%
Project	100m	MP	Time SERIES (LES)	ERA5	-2.06%	-0.33%	-5.87%



Global Wind Atlas 2.0 Microscale check: 10m/s, 750W/m^2 @ 100m

2-Year Measurements
9.88m/s, 773 W/m² @ 80m
~ 10.0 m/s 802 W/m² @ 100m

Comments

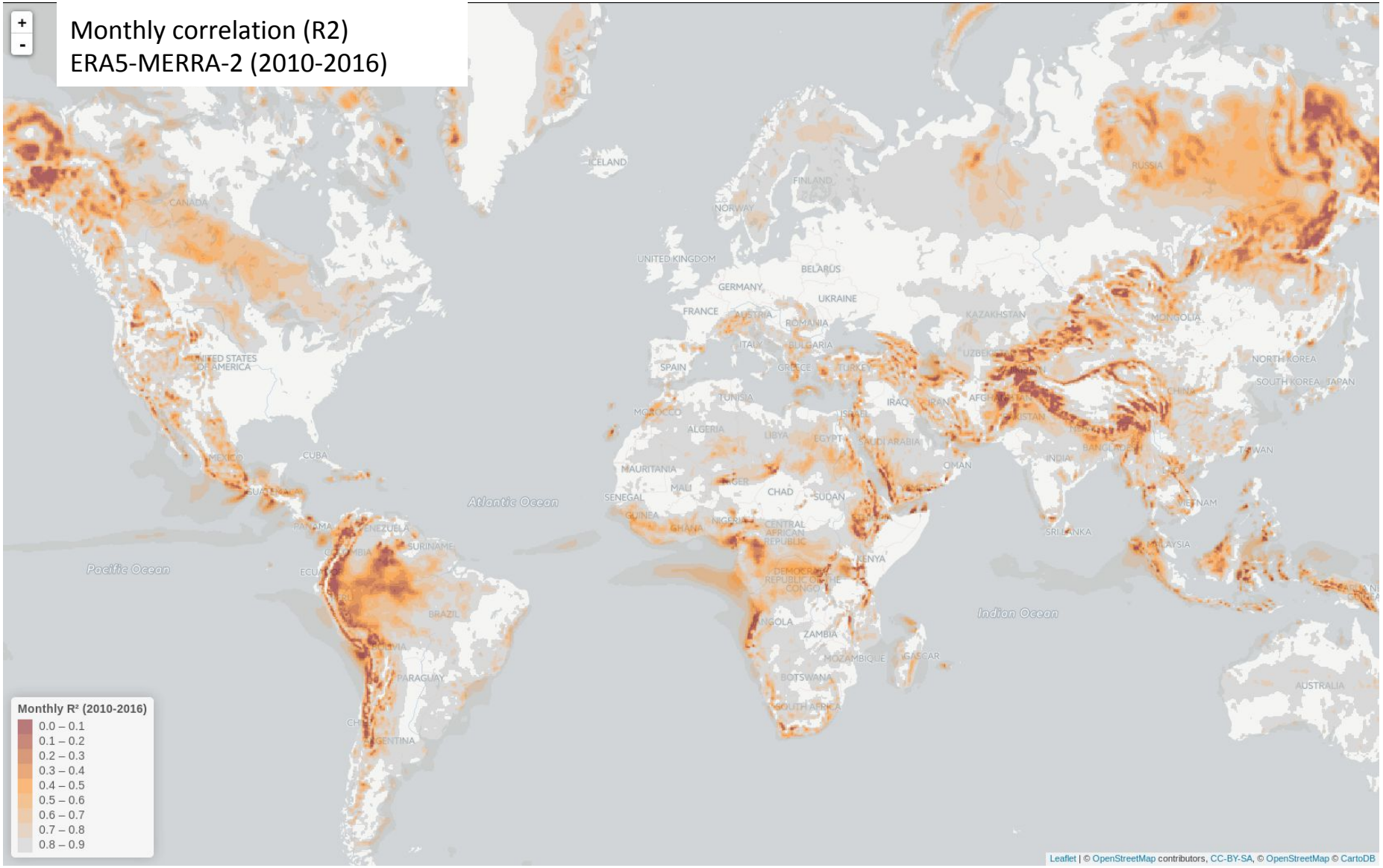
Wind resource complexity has a multiscale source

At Mesoscale level, drivers & resolution are critical

ERA5 show very promising results

Gulf of Suez Challenge is done

Epilogue: a map of difference between ERA5 & MERRA-2



Wind resource grand challenges: Integration of model and measurements The Gulf of Suez case study

Søren Krohn, Soren Krohn Consulting,
Oriol Lacave & Gil Lizcano, Vortex

Soren Krohn Consulting VORTEX