Climate Change

C3S Energy Webinar
Global Wind and Solar Power Energy Indicators

3 July 2024

“The global wind power energy indicator”

Stefano Campostrini (ICS)

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Outline

- Input Data
- Computational Pipeline
- Output Data
- Results
- Future Outlook

Input Data

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Input data:

Tabular windfarms data from thewindpower.net:

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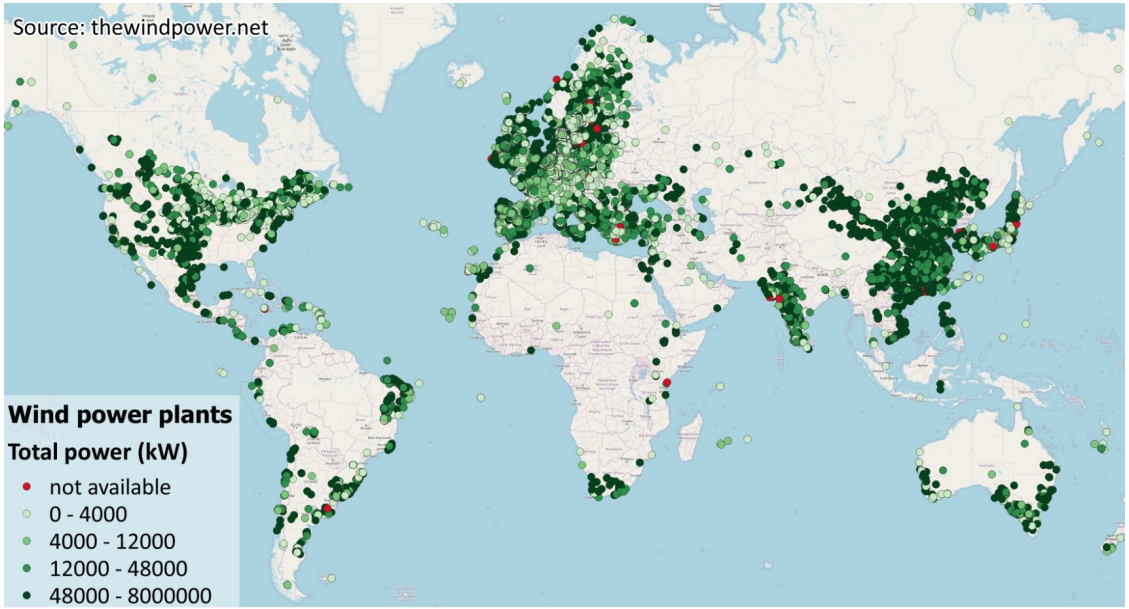
Input Data

Input data:

Tabular windfarms data from thewindpower.net:

- **Power plants locations**



Input Data

Climate Change

Input data:

Tabular windfarms data from thewindpower.net:

- Power plants locations
- **Turbines specifications**

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	ID	Name	Manufacturer ID	Manufacturer	Licence	Wind class	Wind class 2	Offshore	Rated power	Rotor diameter	Swept area	Specific area	Number of blades	Minimum hub height	Maximum hub height	Nacelle weight	Tower weight
2	#ND no data								kW	m	m2	m2/kW		m	m	Tons	Tons
3	1113	2B6	163	2-B Energy	#ND	#ND	#ND	No	6000	140.6	15526.0	2.59	2	95	100	#ND	#ND
4	102	A1000	16	AAER	#ND	#ND	#ND	No	1000	58	2642.1	2.64	3	70	82	#ND	#ND
5	103	A1000S	16	AAER	#ND	#ND	#ND	No	1000	54	2290.2	2.29	3	70	82	#ND	#ND
6	104	A1500-70	16	AAER	#ND	#ND	#ND	No	1500	70	3848.5	2.57	3	65	80	#ND	#ND
7	105	A1500-77	16	AAER	#ND	#ND	#ND	No	1500	77	4656.6	3.10	3	65	80	#ND	#ND
8	556	A1650-70	16	AAER	#ND	#ND	#ND	No	1650	70	3848.5	2.33	3	65	80	#ND	#ND
9	557	A1650-77	16	AAER	#ND	#ND	#ND	No	1650	77	4656.6	2.82	3	65	80	#ND	#ND
10	558	A1650-80	16	AAER	#ND	#ND	#ND	No	1650	80	5026.5	3.05	3	65	80	#ND	#ND
11	1085	A1650-82	16	AAER	#ND	#ND	#ND	No	1650	82	5281.0	3.20	3	#ND	#ND	#ND	#ND
12	106	A2000-71	16	AAER	#ND	#ND	#ND	No	2000	71	3959.2	1.98	3	65	100	#ND	#ND
13	107	A2000-80	16	AAER	#ND	#ND	#ND	No	2000	80	5026.5	2.51	3	65	100	#ND	#ND
14	108	A2000-84	16	AAER	#ND	#ND	#ND	No	2000	84	5541.8	2.77	3	65	100	#ND	#ND
15	231	AW-1300/60GL	46	Acciona	#ND	IEC I	#ND	No	1300	60	2827.4	2.17	3	#ND	#ND	#ND	#ND
16	228	AW-1300/70GI	46	Acciona	#ND	IEC II	#ND	No	1300	70	3848.5	2.96	3	#ND	#ND	#ND	#ND
17	202	AW-1300/70GL	46	Acciona	#ND	IEC III	#ND	No	1300	70	3848.5	2.96	3	#ND	#ND	#ND	#ND
18	179	AW-1500/70	46	Acciona	#ND	IEC Ia	#ND	No	1500	70	3848.5	2.57	3	60	80	52.5	135

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Input Data

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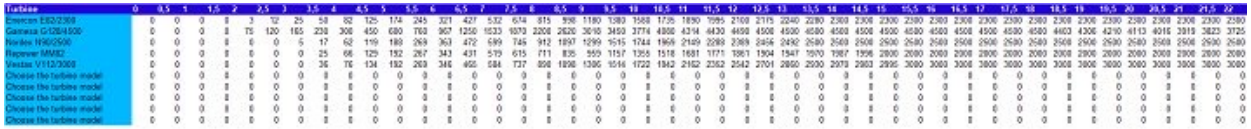
Input data:

Tabular windfarms data from thewindpower.net:

- Power plants locations
- Turbines specifications
- **Power curves**



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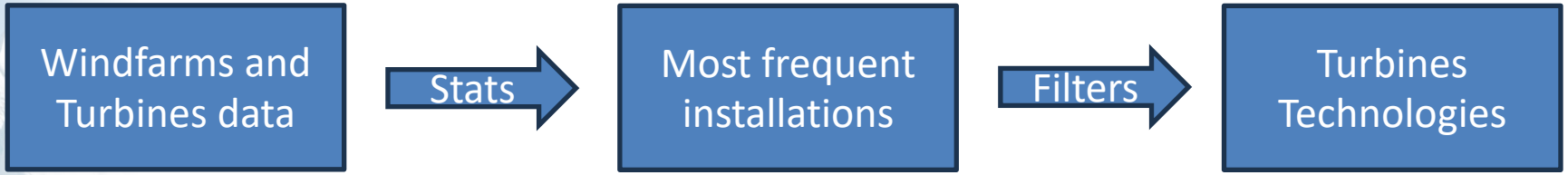
Computational Pipeline



- How recent
- Onshore/Offshore
- Power curves available
- Data cleaning

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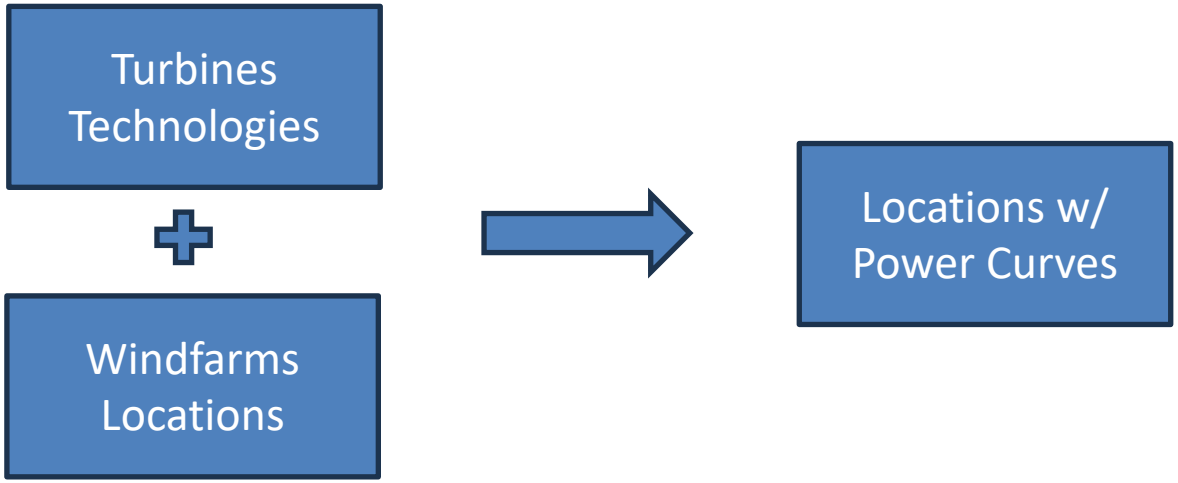
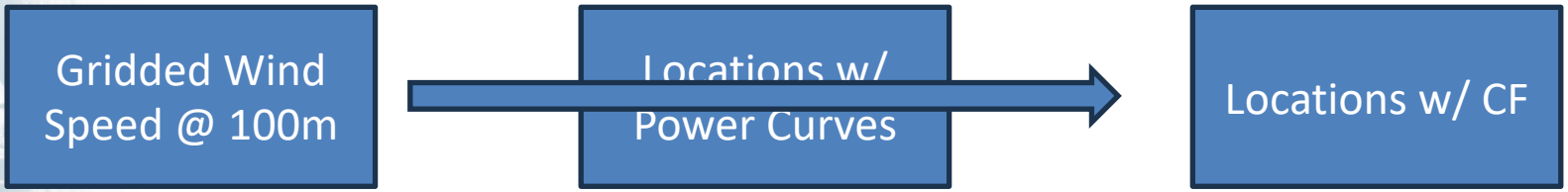
The most frequent turbines provided by thewindpower.net and selected for the wind power model.

Type	Description	Manufactured by
Onshore	5.3-158	GE Energy
	126 4.8 MW	ENO Energy
	AGW 147/4.2	WEG
	114 4.0 MW	ENO Energy
	4.2M118 NES	Senvion
Offshore	SG 8.0-167 DD	Siemens-Gamesa

Computational pipeline



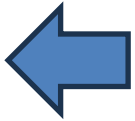
Computational pipeline



Computational Pipeline

Computational pipeline / Output Data

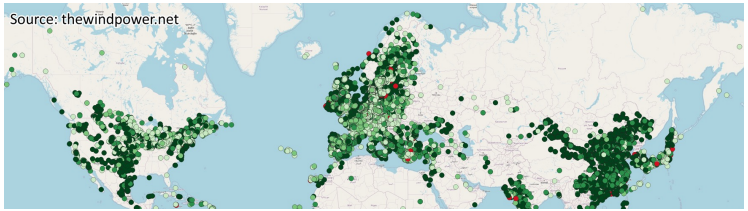
- **Gridded** CF data at global scale with the same resolution as the wind-speed Data
- **Aggregated** CF data at **ADMIN 0,** ADMIN 1 Offshore and Onshore



Locations w/ CF

Output Data

Computational pipeline / Output Data



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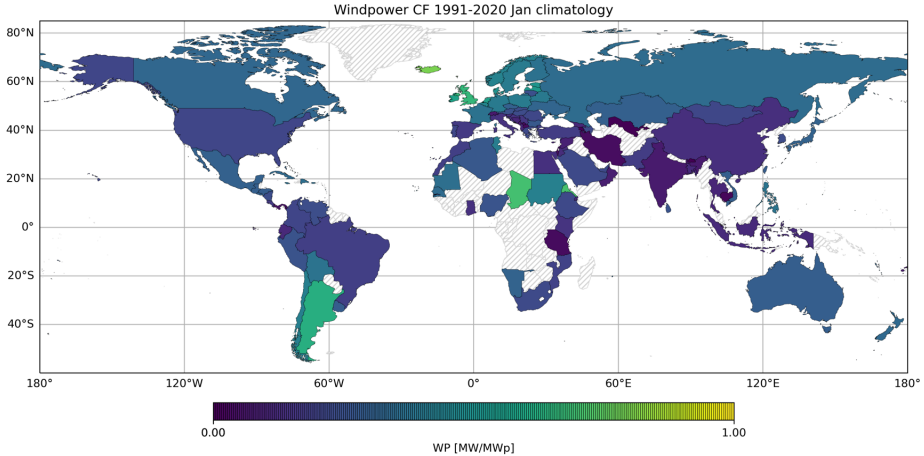

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Projections Results

Wind Speed and Capacity Factor seasonal climatologies for winter (DJF), spring (MAM), summer (JJA) and autumn (SON) for the time range 2021 – 2050. Italy onshore ADM0 region.

Model, Scenario, Season	Wind Speed [m/s]	Capacity Factor [MW/MW]
BCCS, SP245, DJF	3.628	0.146
CMR5, SP370, DJF	3.789	0.164
BCCS, SP245, MAM	3.381	0.107
CMR5, SP370, MAM	3.439	0.116
BCCS, SP245, JJA	2.812	0.049
CMR5, SP370, JJA	2.799	0.052
BCCS, SP245, SON	3.224	0.089
CMR5, SP370, SON	2.999	0.071

BCCS = BCC-CSM2-MR
(Beijijng ClimateCenter ClimateSystem Model)
CMR5 = CMCC-CM2-SR5
(Centro Euro-Mediterraneo Cambiamenti Climatici)

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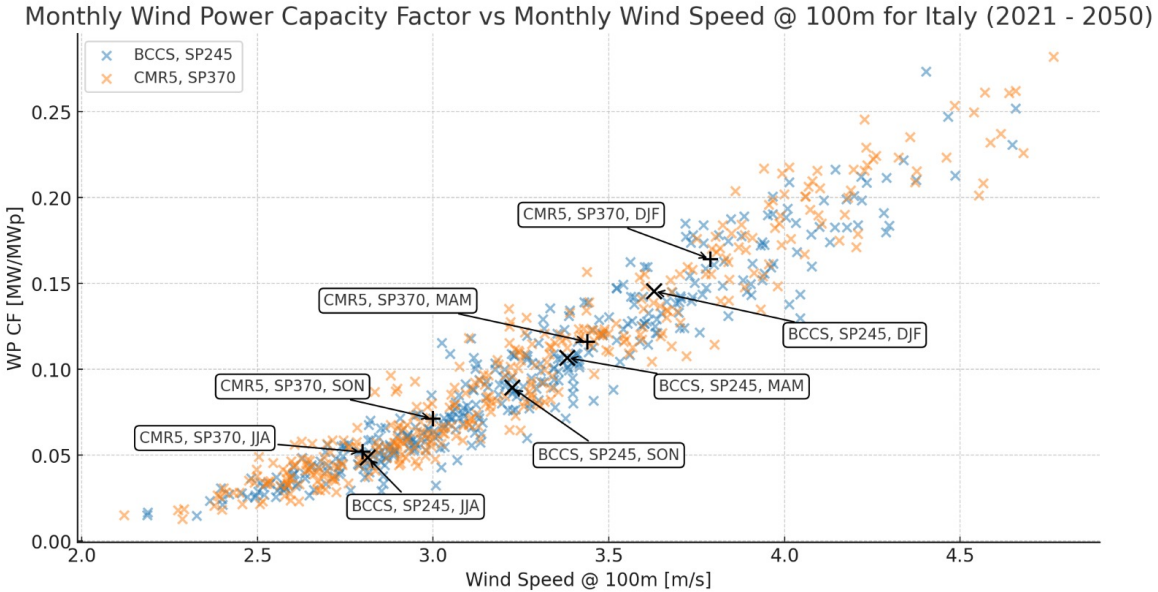
Projections Results

Monthly Wind Speed vs. Monthly Wind Power Capacity Factor scatter plot for data from 2021 to 2050. Italy Onshore ADM0 region. Two model/scenario combinations. The additional black points are the seasonal climatologies of the previous table.



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Seasonal Forecasts Results

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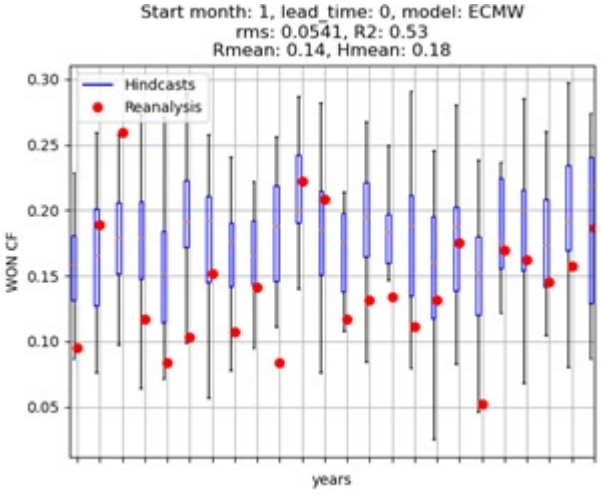

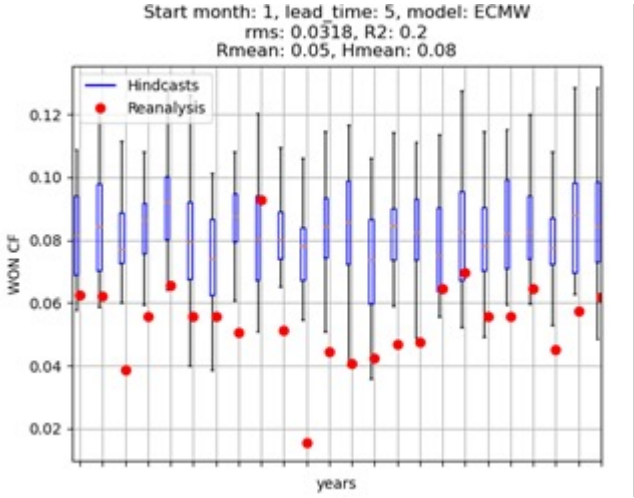

Onshore wind power capacity factors monthly historical versus hindcasts over the 24-year reference period, for the January start date, averaged over ADM0 Italy. Left panel: lead time 0. Right panel: lead time 5. The values of root mean square error (rms) and the mean value over the 24 years of historical (Rmean) and hindcasts (Hmean) are reported within the title of the plot.

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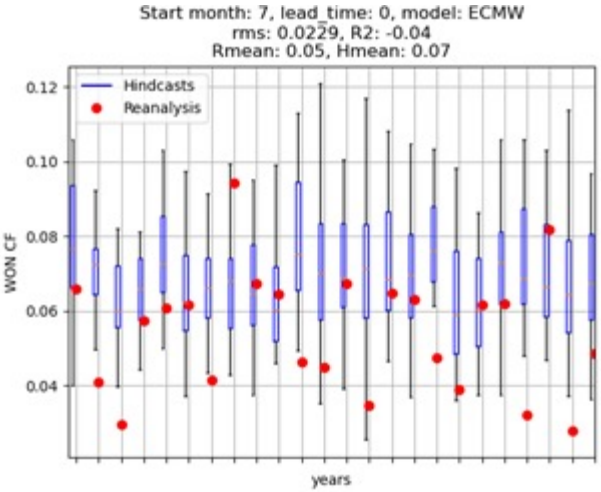
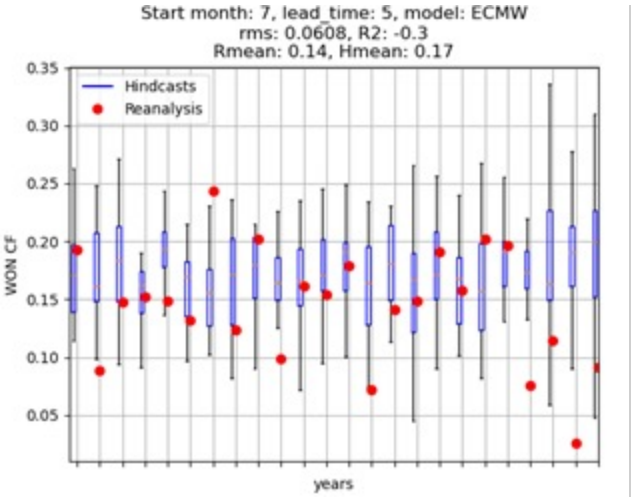
Seasonal Forecasts Results





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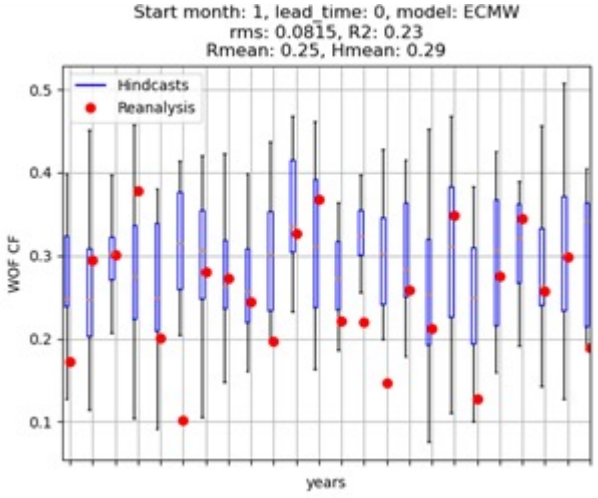

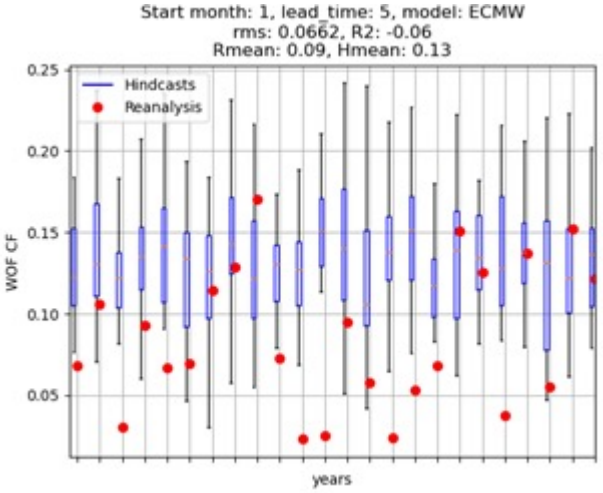

Offshore wind power capacity factors monthly historical versus hindcasts over the 24-year reference period, for the January start date, averaged over ADM0 Italy. Left panel: lead time 0. Right panel: lead time 5. The values of root mean square error (rms) and correlation (R2) and the mean value over the 24 years of historical (Rmean) and hindcasts (Hmean) are reported within the title of the plot.

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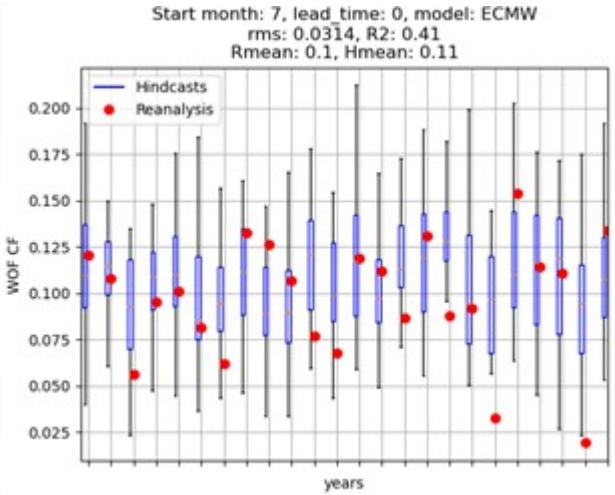

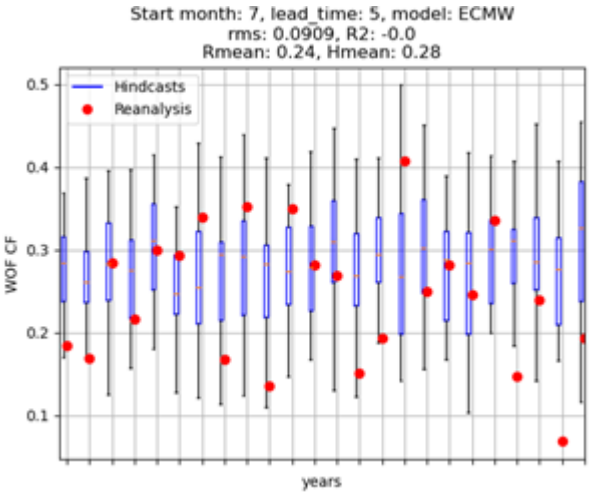

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Future Outlook

- Better coverage through a different approach in the selection of the wind power plant locations, such as computation of the Capacity Factors at every grid point, and aggregation performed ignoring data from "exclusion areas."

- Runs with different technologies to allow users to have more choices and representativeness.

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THANK YOU

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