UN APPROCCIO SOCIO-AMBIENTALE ALLA PIANIFICAZIONE DI PARCHI EOLICI OFF-SHORE. IL CONTRIBUTO DEL PROGETTO IPA ADRIATICO "POWERED" ALLE BEST PRACTICES, ALLA MITIGAZIONE DEGLI IMPATTI E ALL'ANALISI AMBIENTALE

SMART Energy Expo, Sala Puccini, Centro Congressi Arena, VERONA, October 11th 2013

Il progetto POWERED: un passo per la conoscenza degli scenari futuri dell' energia eolica off-shore nel bacino del mare Adriatico

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EUROPEAN WIND POWER CAPACITY

COUNTRY	End 2012						Wind power share of total electricity consumption (%)
	Energy Action Plans al 2012 (MW)		Real Installed (MW)		Difference		
	Onshore	Offshore	Onshore	Offshore	onshore	offshore	
Austria	1435	0	1378	0	↓	---	4
Belgio	720	503	996	380	↑	↓	4
Bulgaria	451	0	684	0	↑	---	4
Cipro	114	0	147	0	↑	---	6
Rep. Ceca	343	0	260	0	↓	---	1
Danimarca	2985	856	3241	921	↑	↑	27
Estonia	311	0	269	0	↓	---	6
Finlandia	380	0	262	26	↓	↑	1
Francia	7598	667	7564	0	↓	↓	2
Germania	30566	792	31027	280	↑	↓	11
Grecia	2521	0	1749	0	↓	---	6
Ungheria	445	0	329	0	↓	---	2
Irlanda	2334	36	1713	25	↓	↓	13
ITALIA	7040	0	8144	0	↑	---	5
Lettonia	49	0	68	0	↑	---	2
Lituania	250	0	225	0	↓	---	4
Lussemburgo	54	0	45	0	↓	---	1
Malta	2	0	0	0	↓	---	0
Olanda	2727	228	2144	247	↓	↑	4
Polonia	2010	0	2497	0	↑	---	3
Portogallo	5600	0	4523	2	↓	↑	17
Regno Unito	5970	2650	5497	2948	↓	↑	6
Romania	1850	0	1905	0	↑	---	7
Slovacchia	150	0	3	0	↓	---	0
Slovenia	2	0	0	0	↓	---	0
Spagna	23555	0	22796	0	↓	---	16
Svezia	2311	97	3582	164	↑	↑	5
TOTAL	101773	5829	101048	4993	↓	↓	

Rest of Europe: 4922 [MW]

China: 75564 [MW]

North America: 67576 [MW

South America: 3505 [MW]

World Total: 282482 [MW]

Italian electricty consumption: 328.2 [TWh]

Net Italian electricty Production: 287.8 [TWh]

1. Wind: 13.3 [TWh]
2. FV: 18.6 [TWh]
3. Hydro: 43.3 [TWh]
4. Geothermal: 5.3 [TWh]

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OFFSHORE WIND FARM BETWEEN JANUARY 2013 AND JUNE 2013

COUNTRY	N. Wind Farm	N. Foundations installed	N. Turbines installed	N. Turbines connected	Wind power on Grid (MW)
Belgium	2	25	18	12	73.8
Denmark	1	0	93	98	352.8
Germany	7	155	52	21	105
UK	6	87	82	146	513.5
Spain	1	1	1	0	0
Sweden	1	0	8	0	0
TOTAL	**18**	**268**	**254**	**277**	**1045.1**

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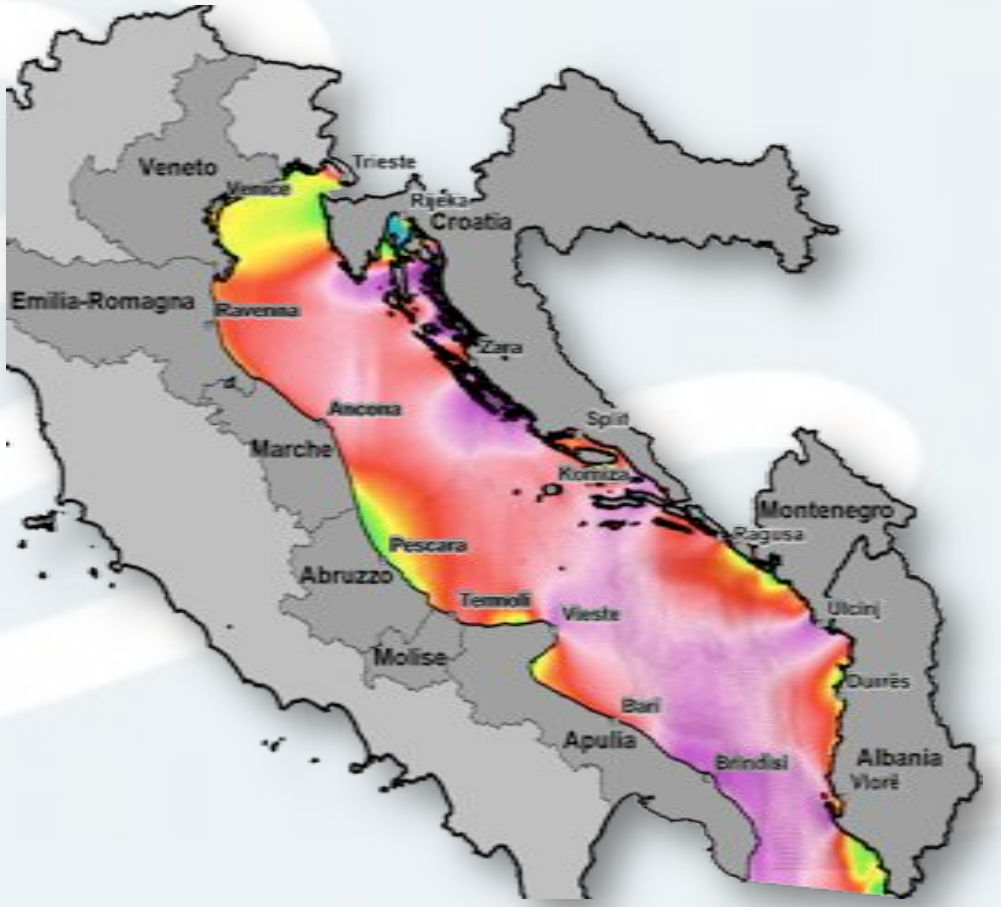
OFFSHORE WIND FARM PROPOSED IN THE ADRIATIC SEA

Wind Farm Name	Developer	Region	Development Status	Capacity (MW)	N.Turbines	Foundation	Water Depth Min (m)	Distance From Shore (km)
Chieuti	Trevi Energy	Puglia	Consent Application Submitted	150	50	Monopile	17	5
Gargano Sud	WPD offshore	Puglia	Consent Application Submitted	342	95	ND	14	10.5
Golfo di Manfredonia	Trevi Energy	Puglia	Consent Application Submitted	300	100	Monopile	15	8
Golfo di Trieste	Ansaldo Sistemi	Friuli-V.G.	Concept	30	ND	ND		24
Margherita di Savoia	Tozzi Holding	Puglia	Concept	720	120	ND	15	5
San Michele	Effeventi srl	Molise	Consent Authorised	162	54	Monopile	0	4.5
TOTAL				1704				

THE AIMS OF THE POWERED PROJECT

- State of art of the Offshore Wind Energy Technology (COMPLETED)
- State of art of the energy policy (COMPLETED)
- Study of the Adriatic sea wind resources (IN PROGRESS)
- Analysis of the potential enviromental impacts of the offshore wind energy in Adriatic sea (IN PROGRESS)
- Analysis of the transports and fishing activities interference (IN PROGRESS)
- Analysis of the available and proposed grid infrastructures (COMPLETED)
- Analysis of the Adriatic Industrial Ports capability (COMPLETED)
- GUIDELINES for the offshore wind energy development in Adratic sea (STARTED)



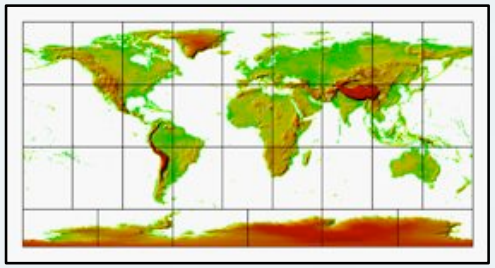
THE PRESENT WORK

1. Description of the simulated area;
2. Description of the adopted Numerical Weather Prediction (NWP) model;
3. Description of the implemented procedure;
4. Analysis of the results;
5. Analysis of the grid resolution on the wind resources results

POWERED PARTNERSHIP

- Abruzzo Region
- Montenegro – Min. of Economy
- Veneto Agricoltura
- Provincia of Ravenna
- Marche Region
- Molise Region
- Apulia Region
- UNIVPM - Ancona
- Cetma Consortium
- Micoperi Marine Contractors Srl
- Italy – Min. for Envir. and Land and Sea
- Albania – Min. Economy, Trade and Energy
- Municipality of Komiza

THE ADOPTED NWP MODEL: MM5v3



DS083.2
METEO DATA

LAM

$$\frac{\partial U}{\partial t} + m_x\left(\frac{\partial(Uu)}{\partial x} + \frac{\partial(Vu)}{\partial y}\right) + \frac{\partial(\Omega u)}{\partial \eta} + \mu_d \alpha \frac{\partial p}{\partial x} + \frac{\alpha}{\alpha_d}\frac{\partial \phi}{\partial x}\frac{\partial p}{\partial \eta} = F_U$$

$$\frac{\partial V}{\partial t} + m_y\left(\frac{\partial(Uv)}{\partial x} + \frac{\partial(Vv)}{\partial y}\right) + \frac{m_y}{m_x}\frac{\partial(\Omega v)}{\partial \eta} + \mu_d \alpha \frac{\partial p}{\partial y} + \frac{\alpha}{\alpha_d}\frac{\partial \phi}{\partial y}\frac{\partial p}{\partial \eta} = F_V$$

$$\frac{\partial W}{\partial t} + \frac{m_x m_y}{m_y}\left(\frac{\partial(Uw)}{\partial x} + \frac{\partial(Vw)}{\partial y}\right) + \frac{\partial(\Omega w)}{\partial \eta} - \frac{1}{m_y} g\left[\frac{\alpha}{\alpha_d}\frac{\partial p}{\partial \eta} - \mu_d\right] = F_W$$

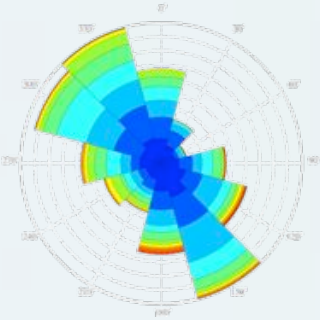
$$\frac{\partial \Theta}{\partial t} + m_x m_y\left(\frac{\partial(U\theta)}{\partial x} + \frac{\partial(V\theta)}{\partial y}\right) + m_y\frac{\partial(\Omega\theta)}{\partial \eta} = F_\Theta$$

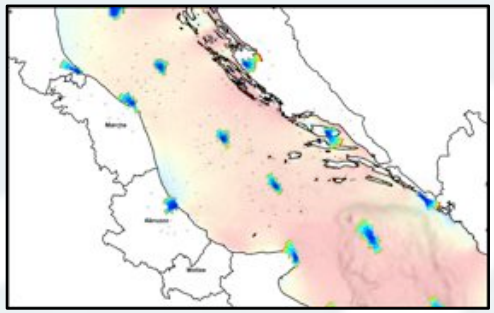
$$\frac{\partial \mu_d}{\partial t} + m_x m_y\left(\frac{\partial U}{\partial x} + \frac{\partial V}{\partial y}\right) + m_y\frac{\partial \Omega}{\partial \eta} = 0$$

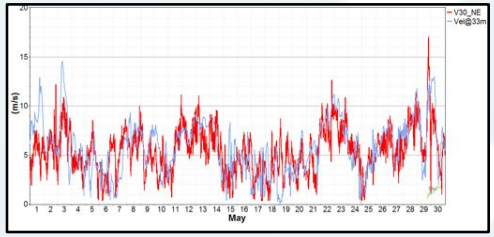
$$\frac{\partial \phi}{\partial t} + \frac{1}{\mu_d}\left[m_x m_y\left(U\frac{\partial \phi}{\partial x} + V\frac{\partial \phi}{\partial y}\right) + m_y\Omega\frac{\partial \phi}{\partial \eta} - m_y g W\right] = 0$$

$$\frac{\partial Q_m}{\partial t} + m_x m_y\left(\frac{\partial(Uq_m)}{\partial x} + \frac{\partial(Vq_m)}{\partial y}\right) + m_y\frac{\partial(\Omega q_m)}{\eta} = F_{Q_m}$$

TERRAIN → REGRID → INTERPF → MM5





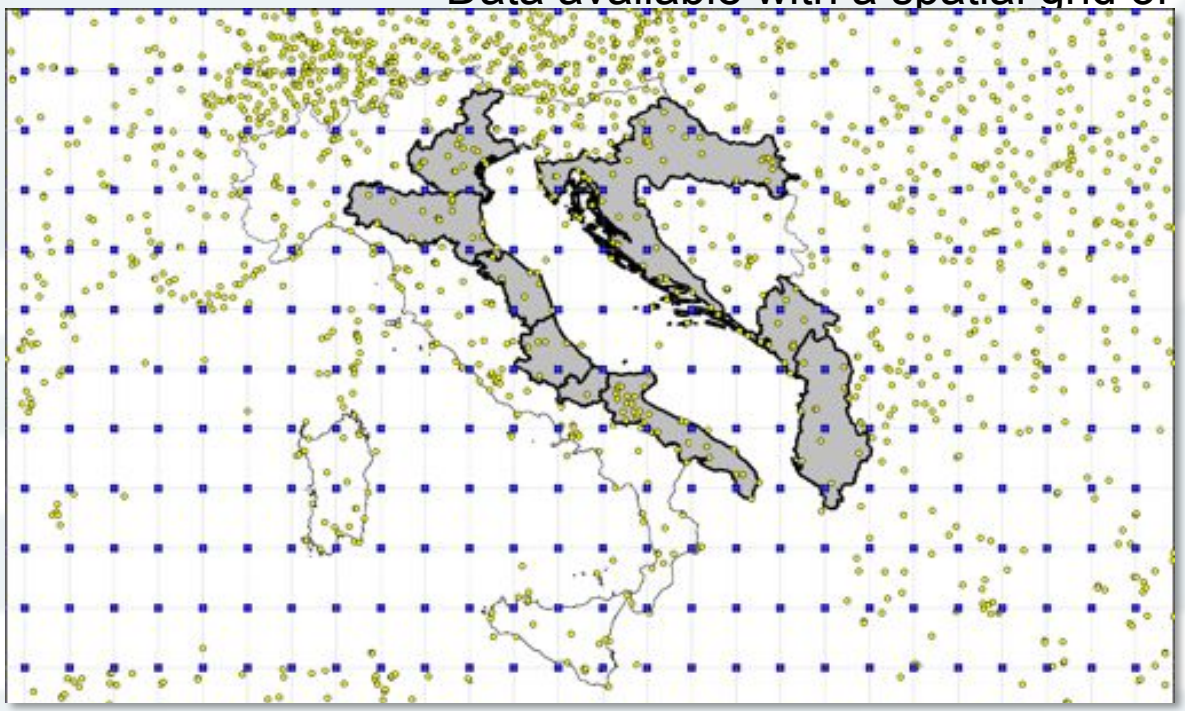


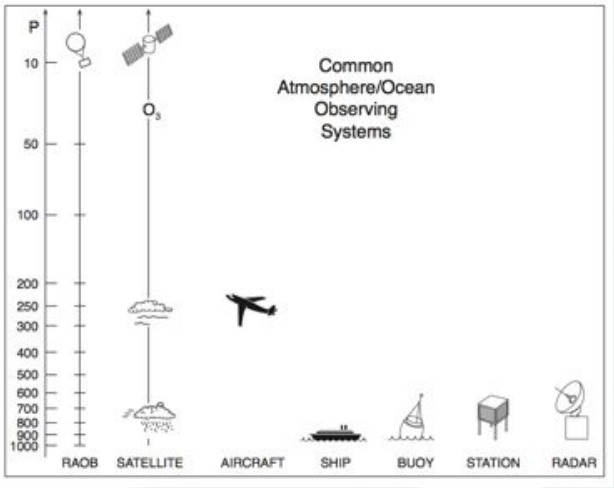
"The PSU/NCAR mesoscale model (known as MM5) is a limited-area, nonhydrostatic, terrain-following sigma-coordinate model designed to simulate or predict mesoscale atmospheric circulation."

THE IMPLEMENTED HINDCASTING PROCEDURE

DS083.2 METEO DATA

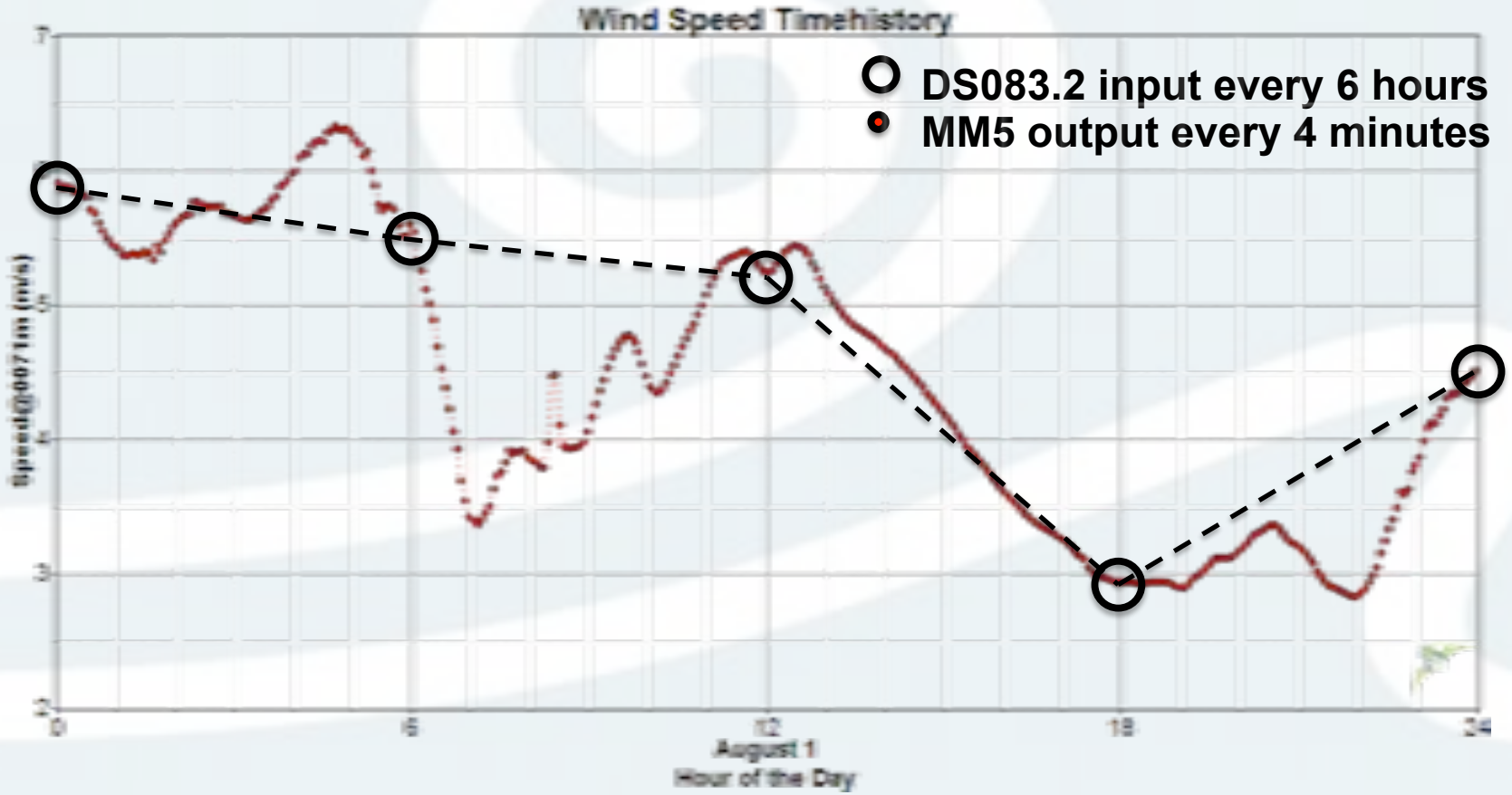
- Meteorological Data deriving from a FNL reanalysis procedure Data available from 1999-07-30 to a near-current date
- Data available with a time step of 6 hour
- Data available with a spatial grid of 1





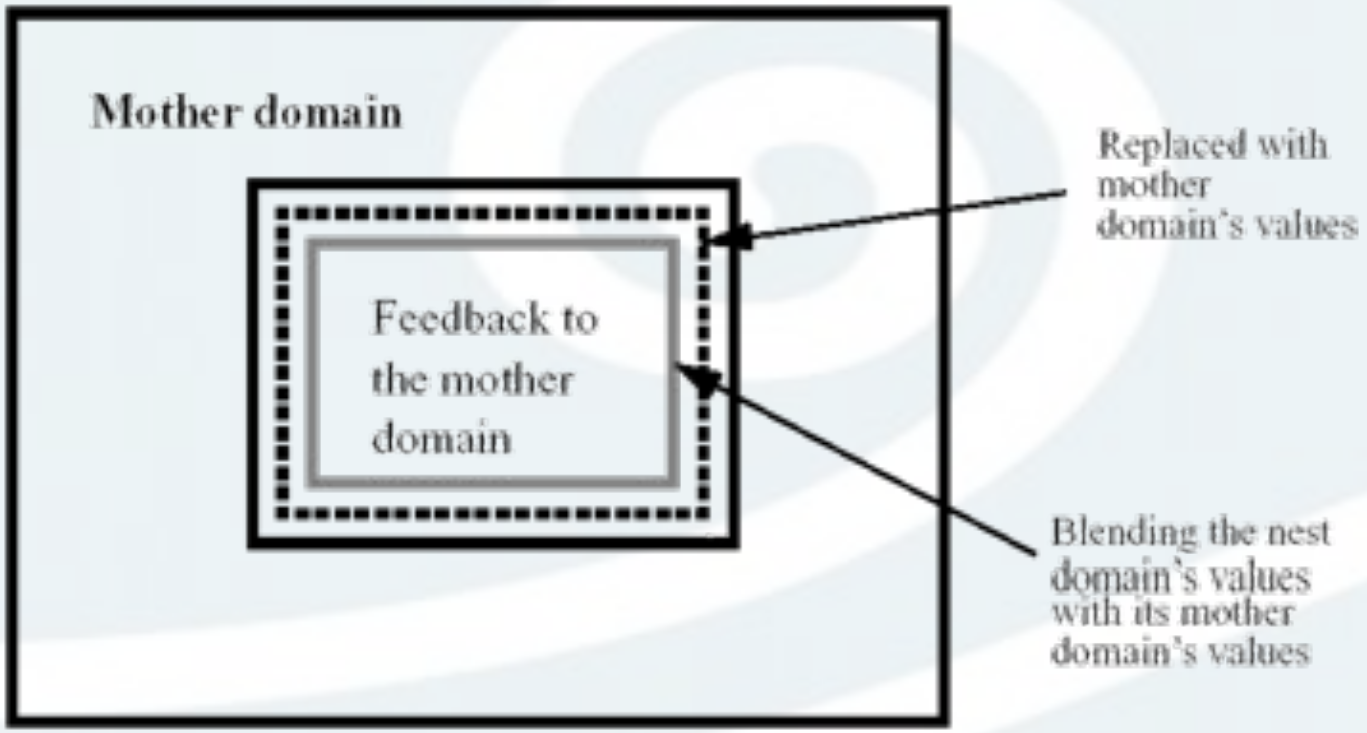
DS083.2 are obtained from the Global Data Assimilation System (GDAS), which continuously collects observational data from the Global Telecommunications System (GTS), and other sources, for many analyses

THE IMPLEMENTED HINDCASTING PROCEDURE



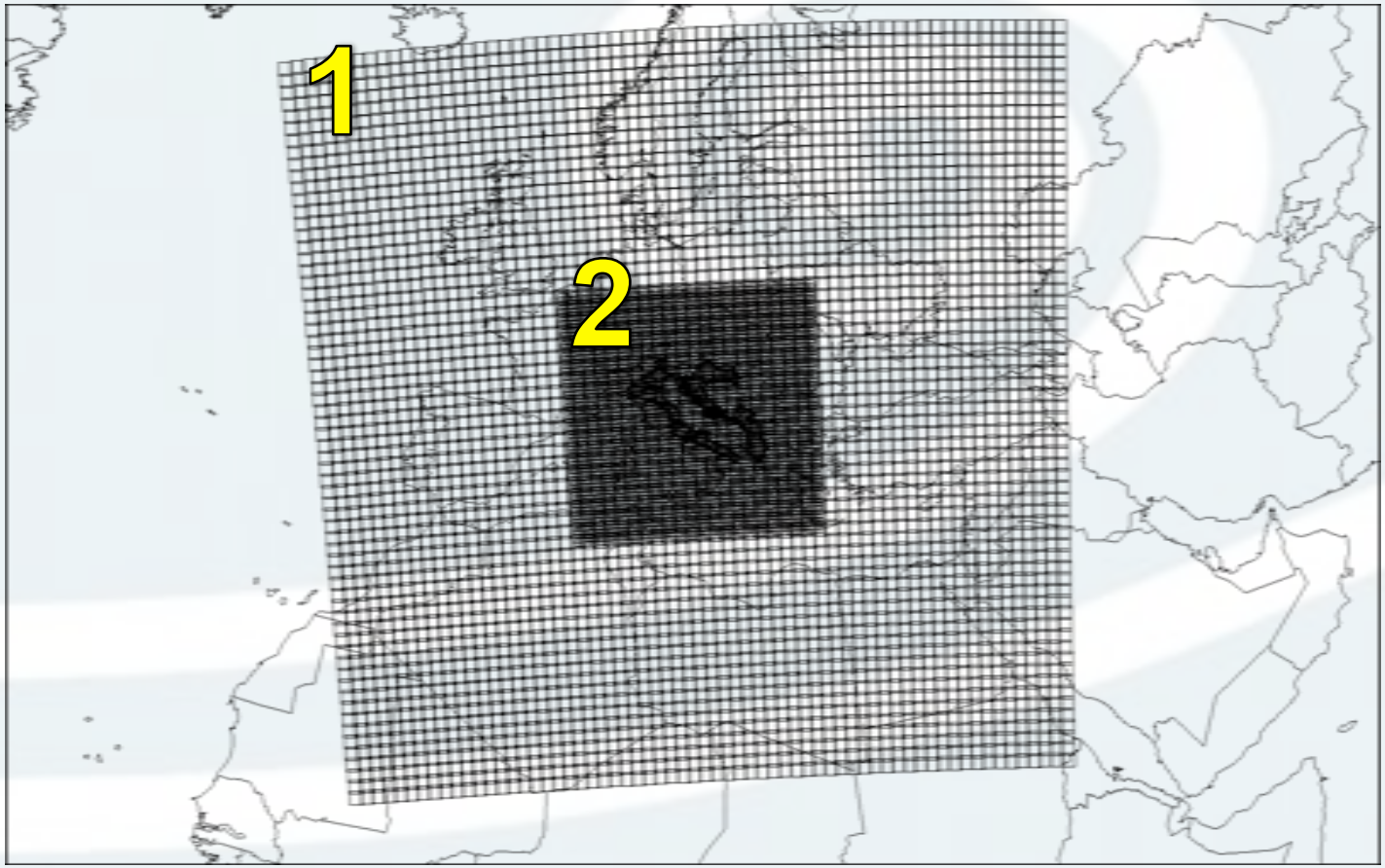
Using the MM5 code is possible to describe the wind behaviour in the period separating two DS083.2 input. This is very useful especially to evaluate the wind turbine energy production.

THE IMPLEMENTED HINDCASTING PROCEDURE



The hindcasting analysis is implemented with a **two way nesting** procedure. In this way the initializing meteo data are ingested by the coarser mother domain and they propagate to the finer nested domains; at the same time the more accurate results of the nested domains are fed back to the mother ones so to improve the global solution accuracy.
Numerical simulations with a 3 [km] horizontal spatial resolution are carried out by using four nested domains, while 1 [km] simulations use five nested domains.

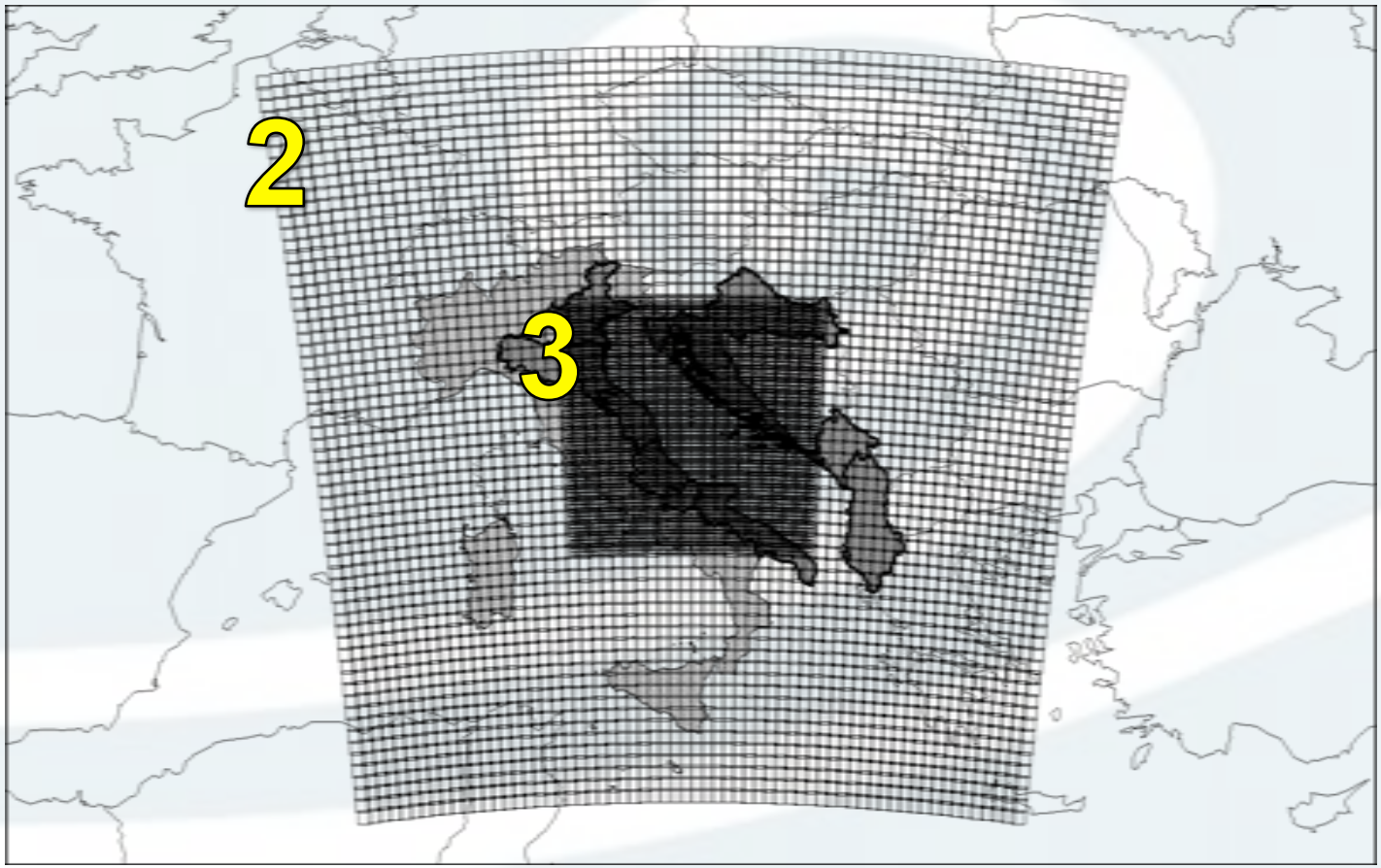
THE IMPLEMENTED HINDCASTING PROCEDURE



DOMAIN-1: Horizontal Spatial Resolution of 81 km (Continental)
DOMAIN-2: Horizontal Spatial Resolution of 27 km (Sub-Continental)

Each calculus domain has the same number of cells but the two way approach imposes a 3:1 growth ratio of the spatial resolution.
The main consequence of these expansion ratio is that the mother domain is so large to cover a large part of Europe and North Africa. With a so large mother domain is possible to fully take in account synoptic phenomena and to propagate their effects to inner domains.

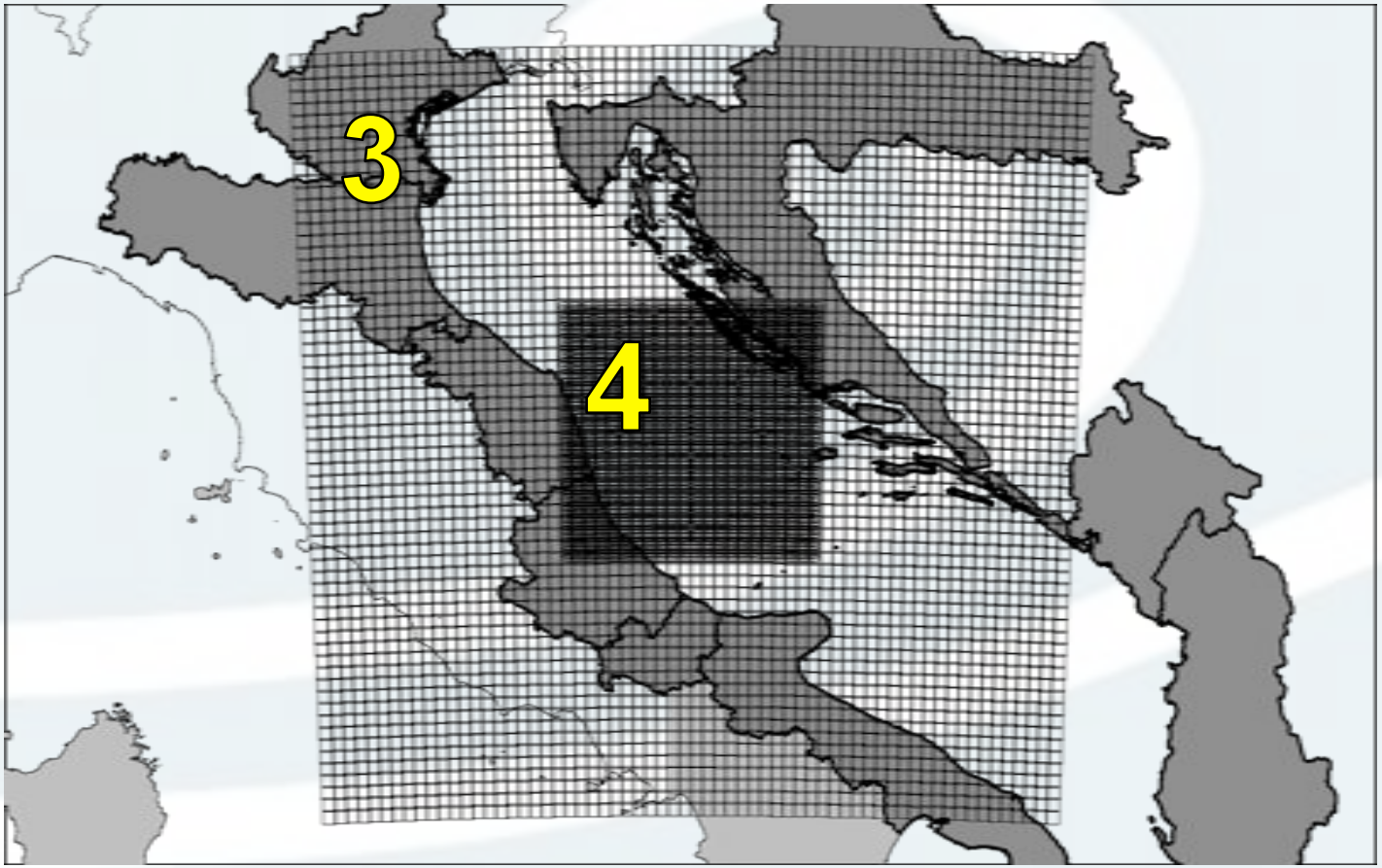
THE IMPLEMENTED HINDCASTING PROCEDURE



In this example the second domain covers all the POWERED partners countries and also the main mountains areas surrounding the Adriatic Basin.

DOMAIN 2 – Horizontal Spatial Resolution of 27 km – Subcontinental
DOMAIN 3 – Horizontal Spatial Resolution of 9 km – Interregional

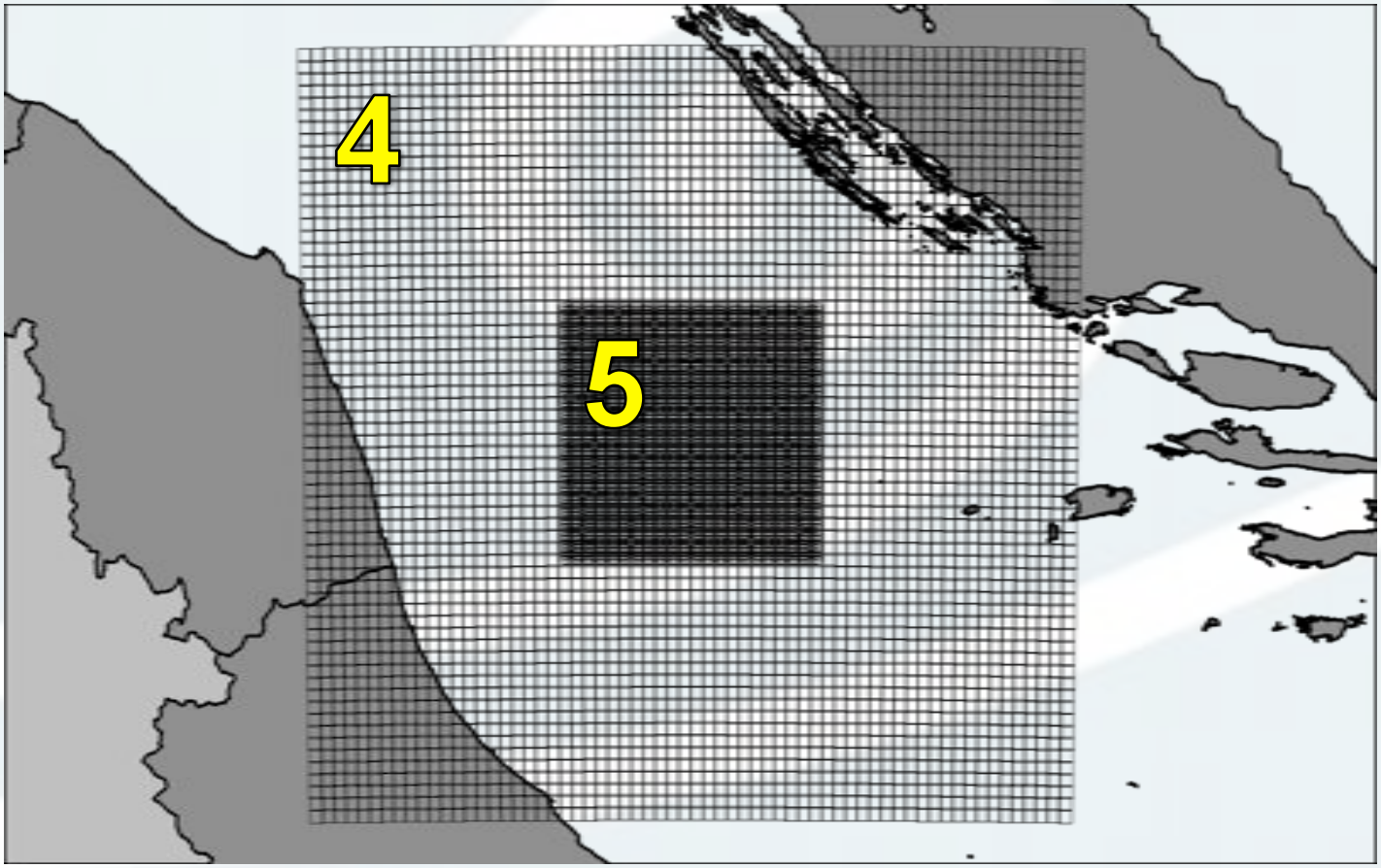
THE IMPLEMENTED HINDCASTING PROCEDURE



The third domain covers part of the Adriatic basin and also a significant area of land surfaces that strongly interacts with wind behaviours.

DOMAIN 3 – Horizontal Spatial Resolution of 9 km - Interregional
DOMAIN 4 – Horizontal Spatial Resolution of 3 km - Regional

THE IMPLEMENTED HINDCASTING PROCEDURE



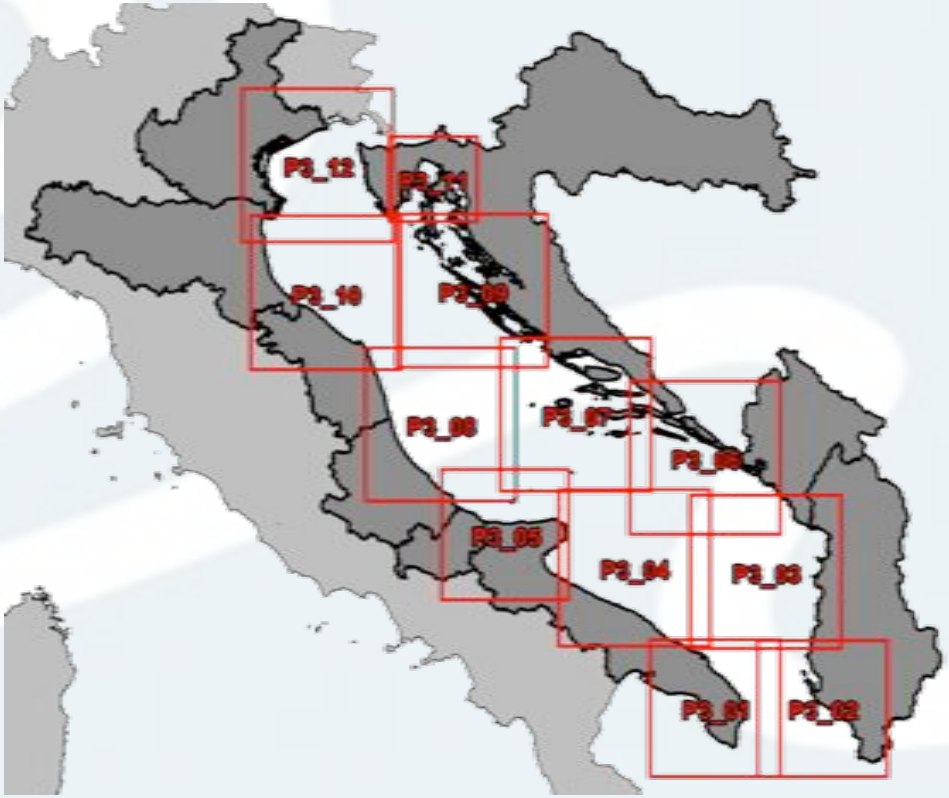
DOMAIN 4 – Horizontal Spatial Resolution of 3 km - Regional
DOMAIN 5 – Horizontal Spatial Resolution of 1 km - Local

The fourth domain is the final step for a 3 [km] Powered analysis while the fifth domain is the final one for the 1 [km] simulations. The finer domains are able to take in account local wind phenomena that originates by interactions with local complex terrains.

DESCRIPTION OF THE SIMULATED AREA

79 DOMAINS HAVING A SPATIAL GRID RESOLUTION OF 1 Km

12 DOMAINS HAVING A SPATIAL GRID RESOLUTION OF 3 Km



Long term analyses are actually obtained with a 3 [km] resolution for the years from 2008 to 2011, while 1 [km] simulations are carried out for the 2010 year.

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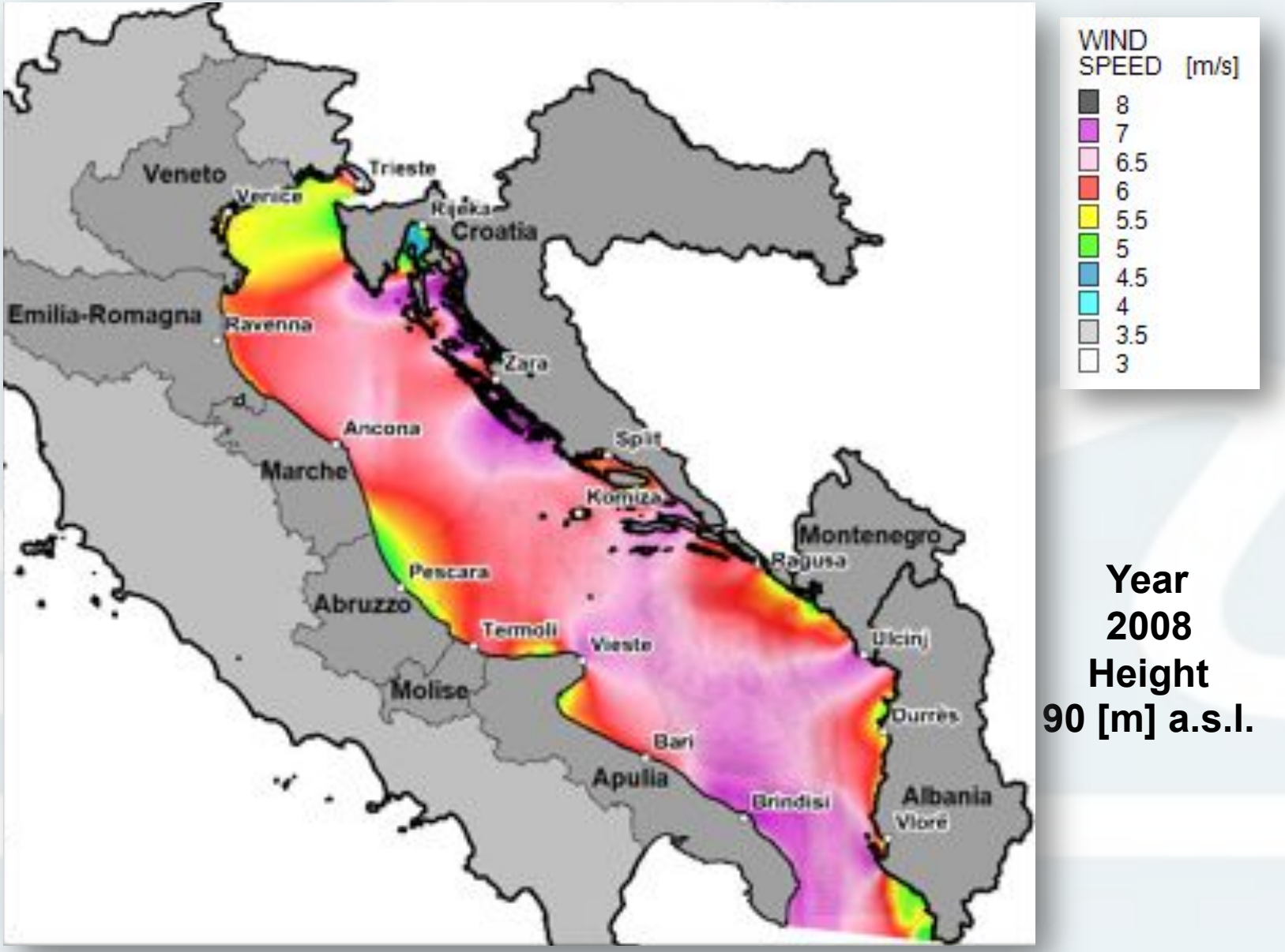
3 KM SIMULATIONS WIND RESULTS - 2008



Year 2008
Height 90 [m] a.s.l.

3 KM SIMULATIONS WIND RESULTS – 2009 VS. 2008

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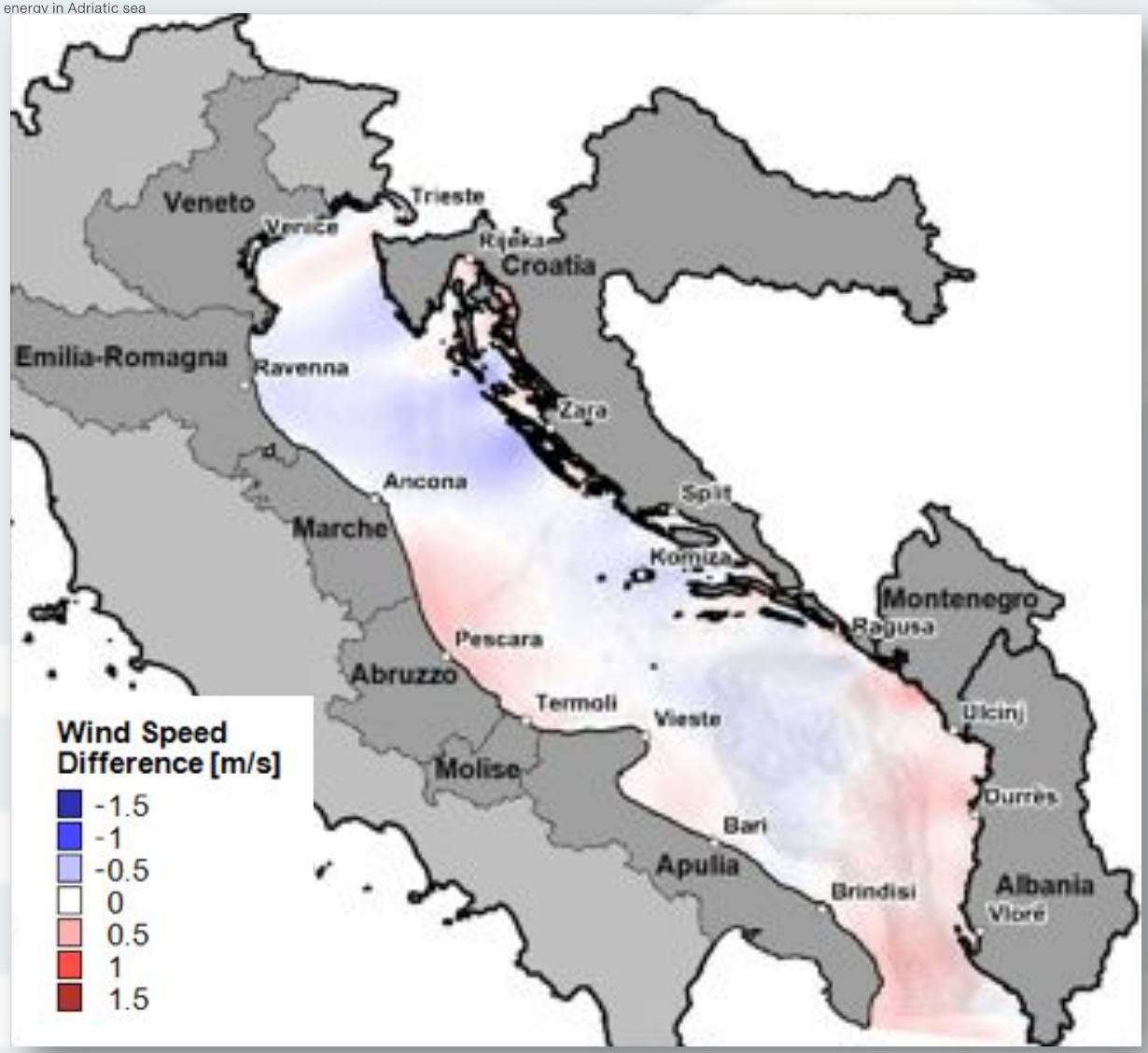
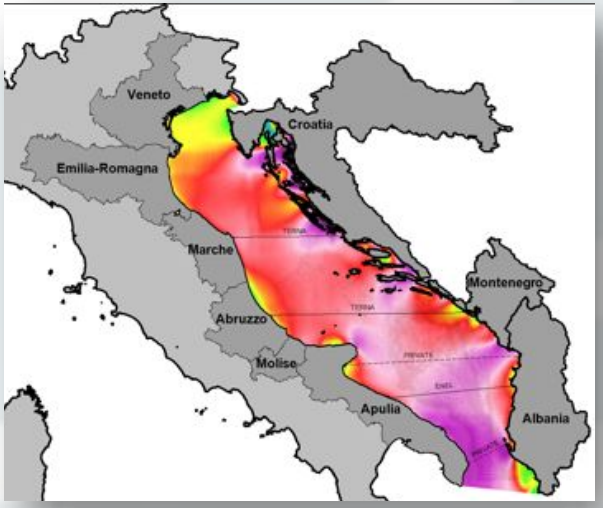


Year 2009 Height 90 [m] a.s.l.



3 KM SIMULATIONS WIND RESULTS – 2010 VS. 2008

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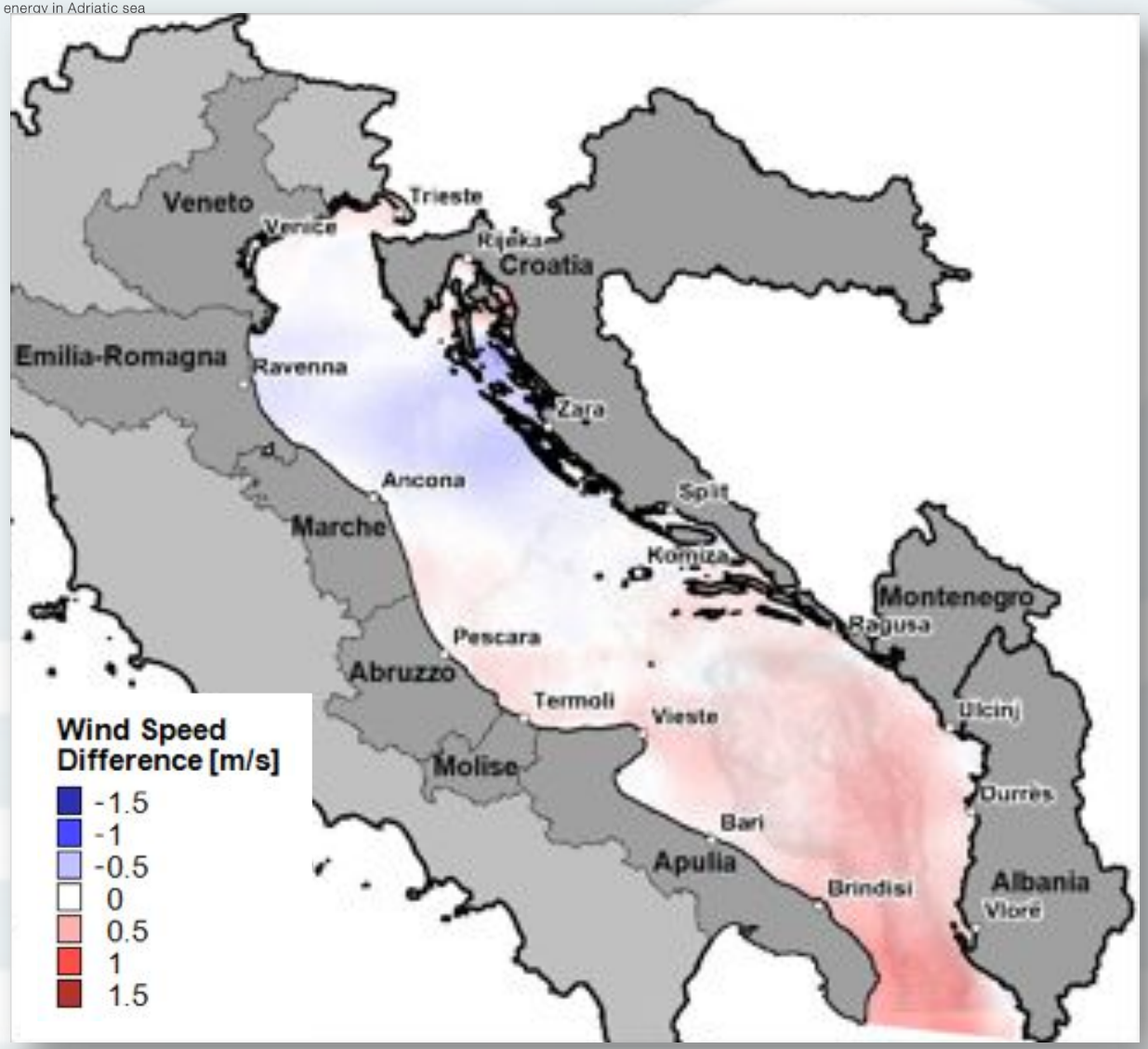
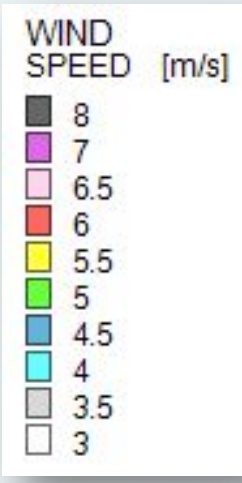
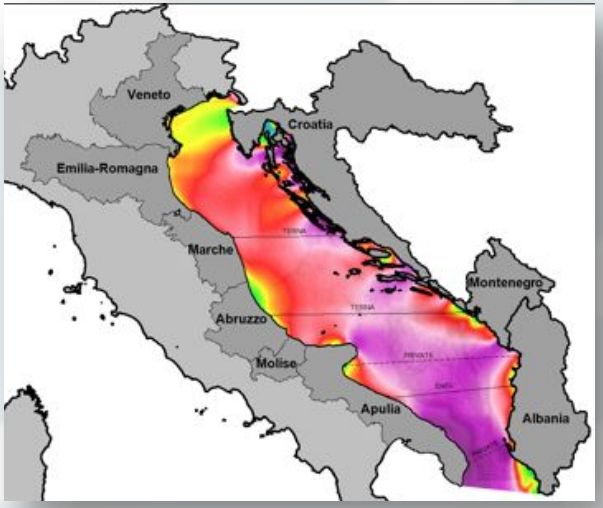




Year 2010 Height 90 [m] a.s.l.



3 KM SIMULATIONS WIND RESULTS – 2011 VS. 2008

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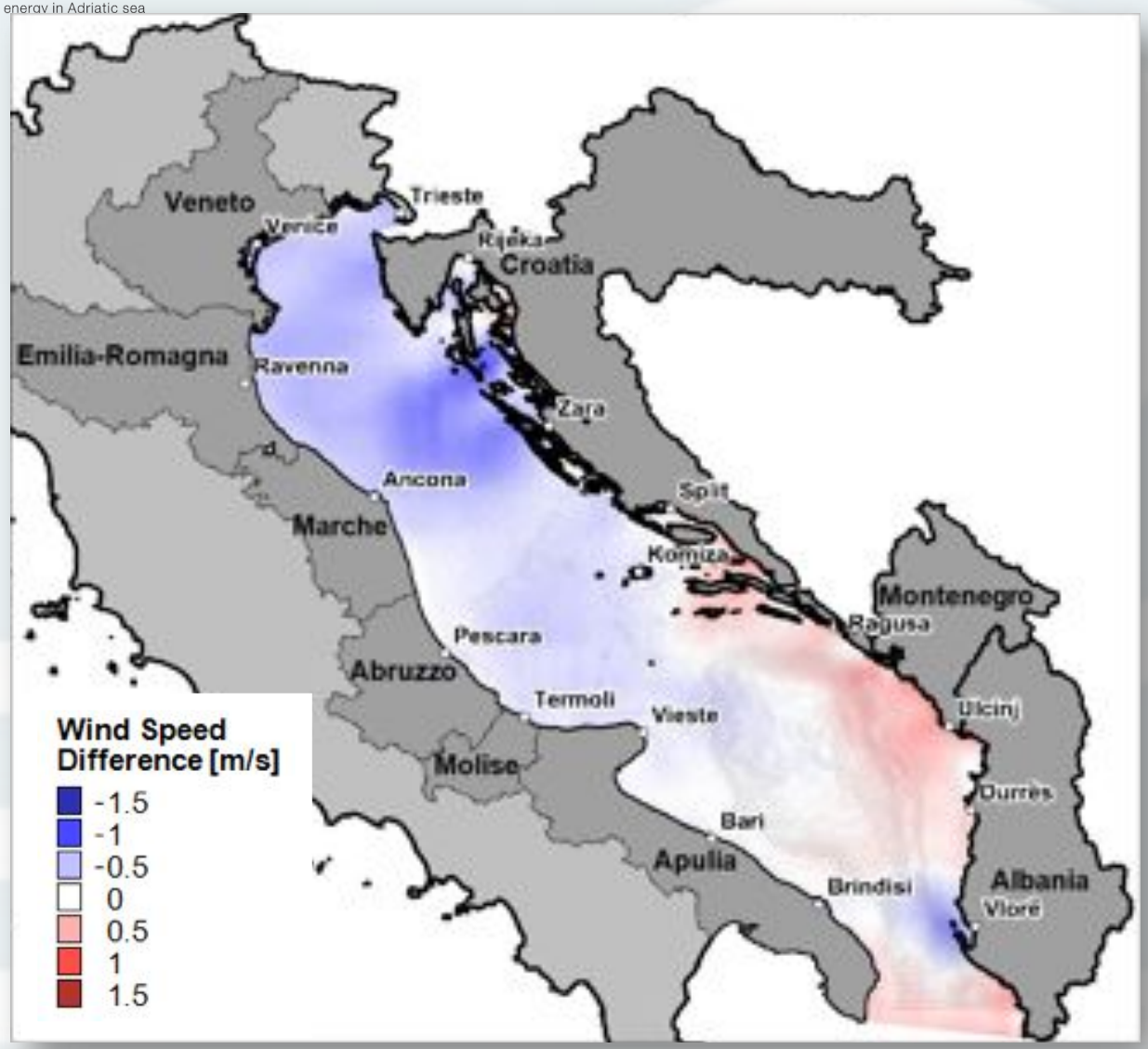

Year 2011 Height 90 [m] a.s.l.