



Università degli Studi di Genova  
Dipartimento di Ingegneria delle Costruzioni, dell'Ambiente e del Territorio



# L'eolico sulle coste e nei contesti portuali

(Wind energy in coastal areas and ports)

Massimiliano Burlando

**Green Ports**  
Genova, 10-11 Novembre 2011



# Copenhagen





# Hamburg





# Bremerhaven





# Cagliari





- **Wind in coastal areas**
- **The project “Vento e Porti”**
- **Conclusions: not only onshore**

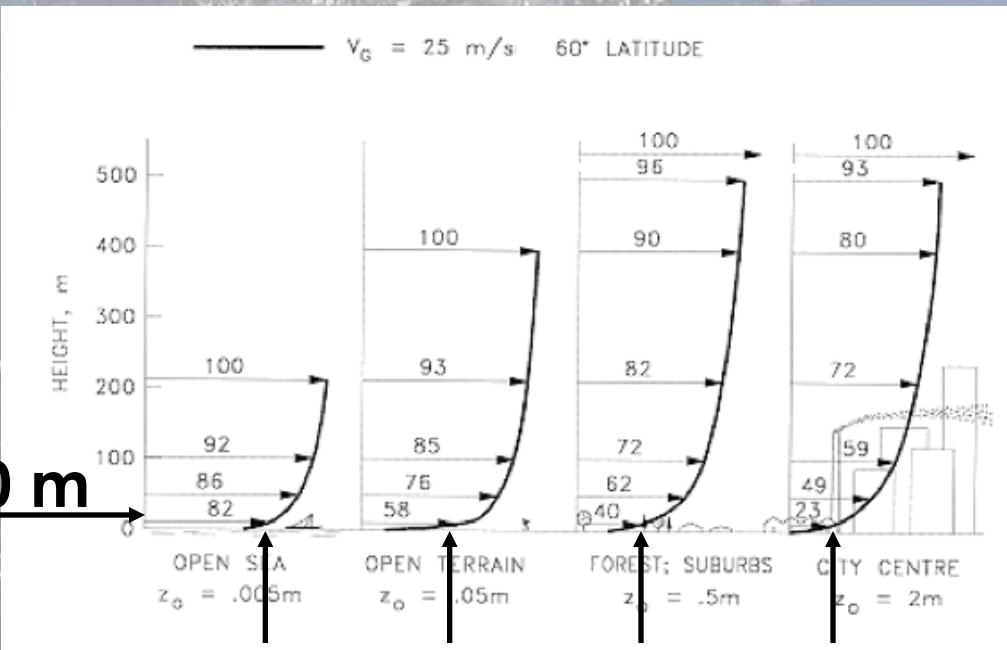
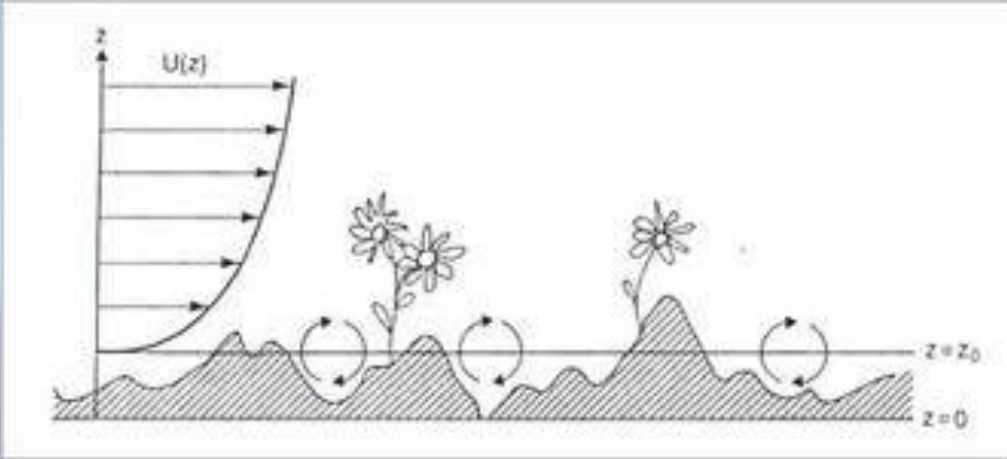


# Wind in coastal areas





# Wind in coastal areas



10 m

82% 58% 40% 23%

- Lower the surface roughness, higher the wind speed (at a fixed height)

- Lower the surface roughness, lower the turbulence and gusts

- Better quality of the wind --> more energy, but also...

- Areas suitable for small wind turbines



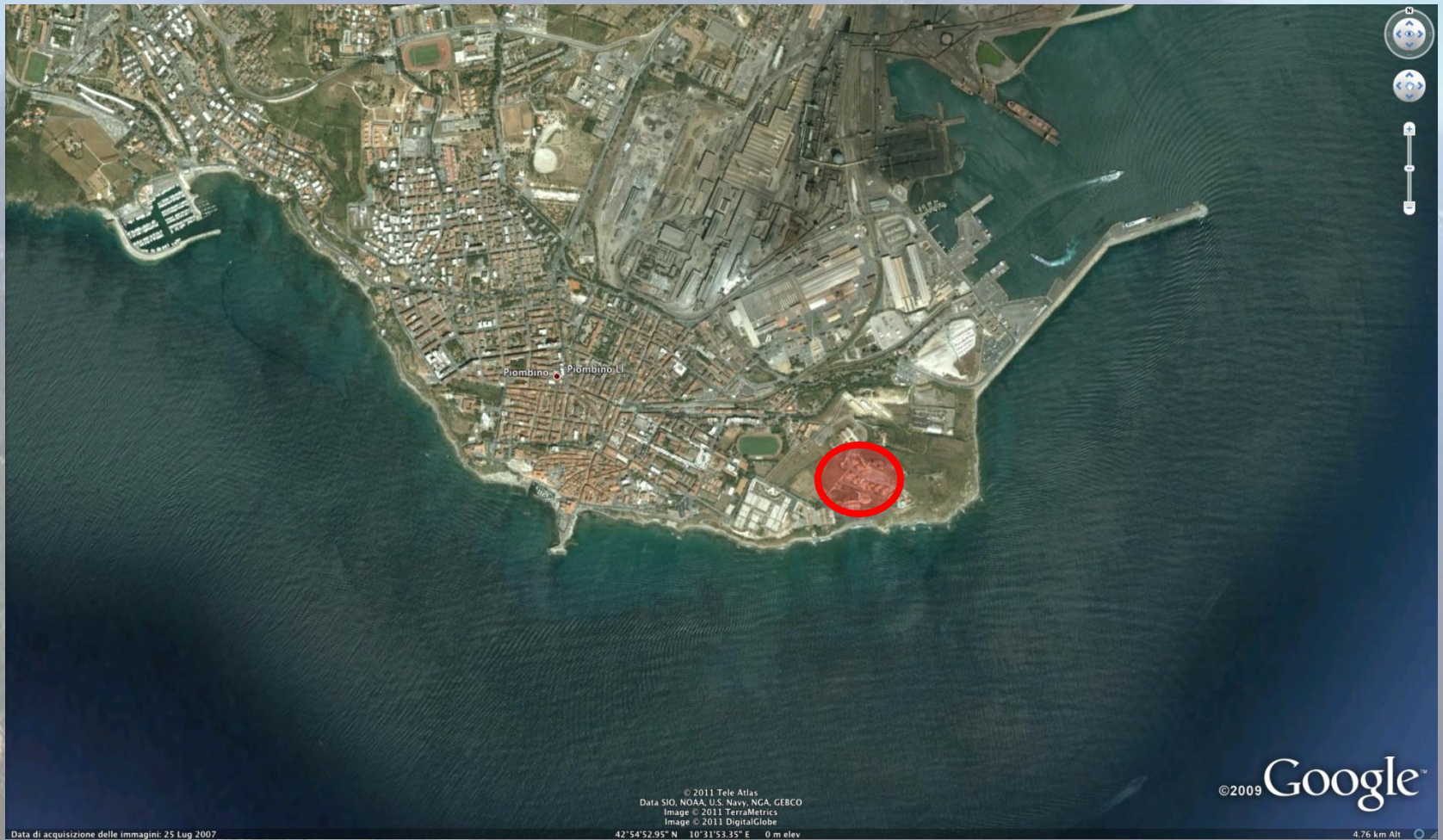


**Warning: siting of small wind turbines is still very difficult and results are sometimes unpredictable**



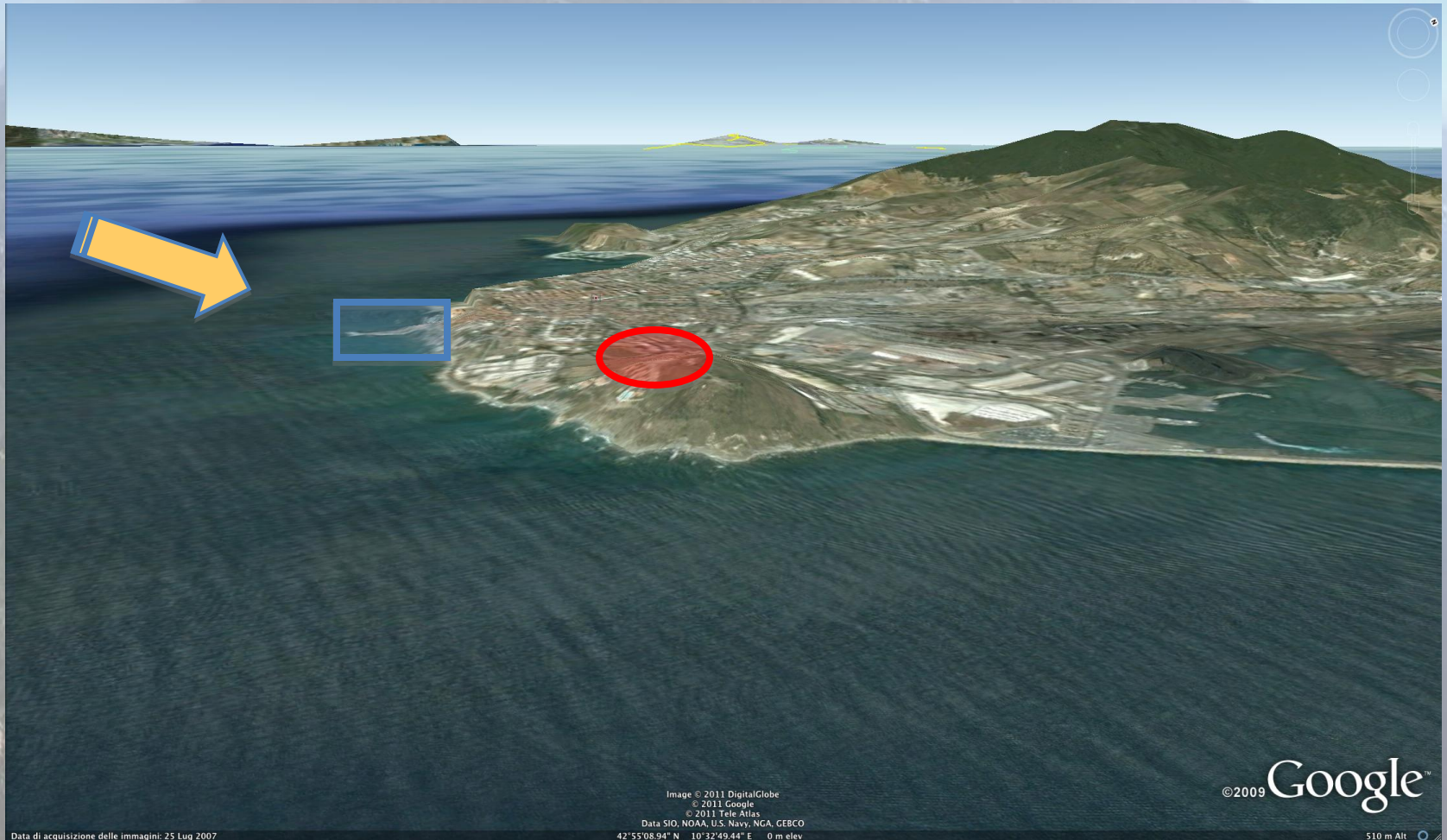


# Wind in coastal areas



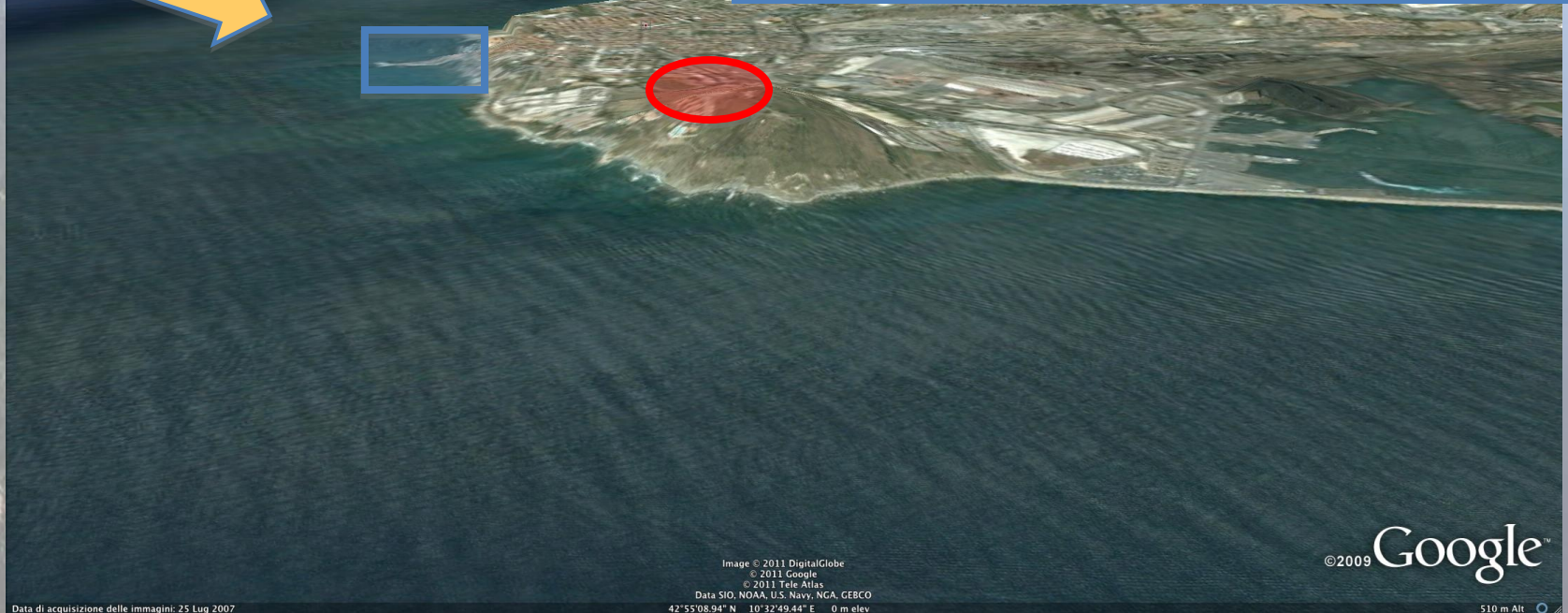


# Wind in coastal areas





# Wind in coastal areas



Data di acquisizione delle immagini: 25 Lug 2007

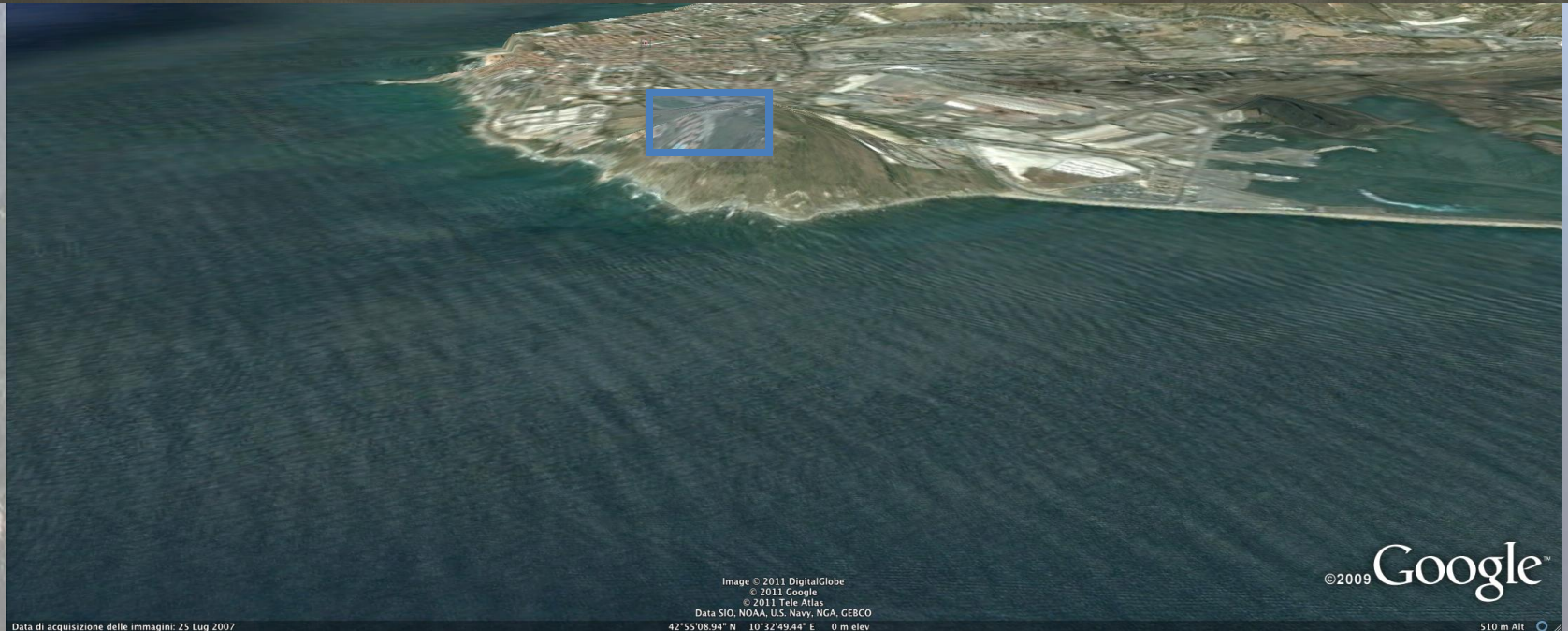
Image © 2011 DigitalGlobe  
© 2011 Google  
© 2011 Tele Atlas  
Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
42°55'08.94" N 10°32'49.44" E 0 m elev

©2009 Google™

510 m Alt



# Wind in coastal areas



Data di acquisizione delle immagini: 25 Lug 2007

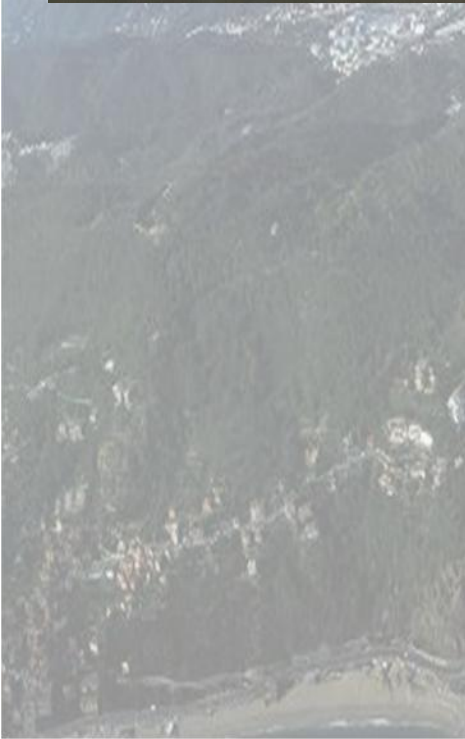
Image © 2011 DigitalGlobe  
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
42°55'08.94" N 10°32'49.44" E 0 m elev

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510 m Alt



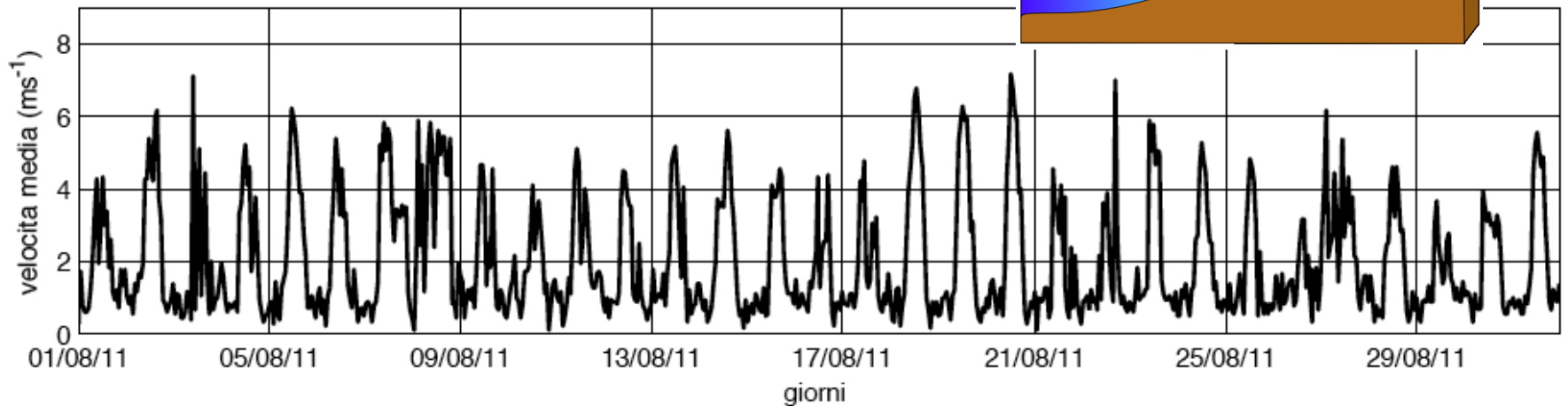
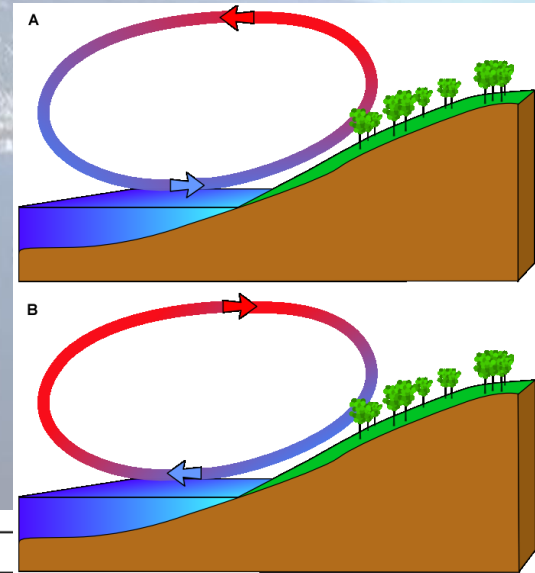
# Wind in coastal areas





## Other aspects favorable to wind energy exploitation along the coasts

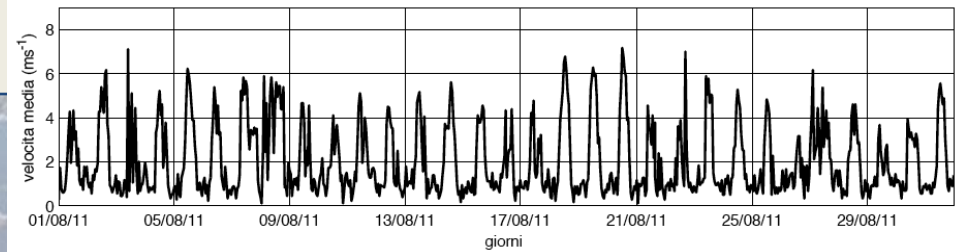
Sea and land breezes



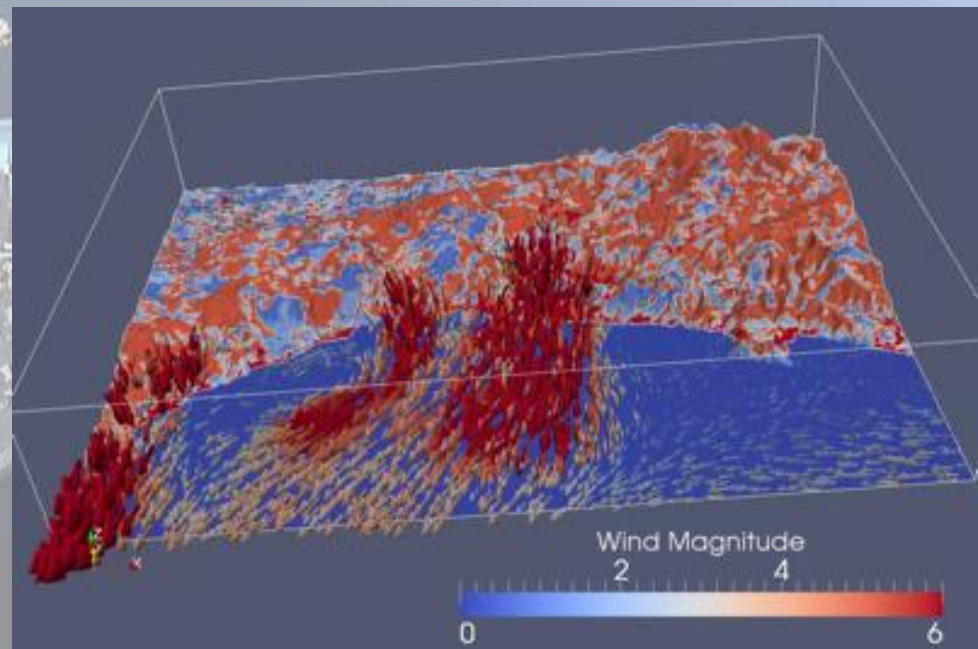


## Other aspects favorable to wind energy exploitation along the coasts

Sea and land breezes



Topographic forcing







# Wind in coastal areas

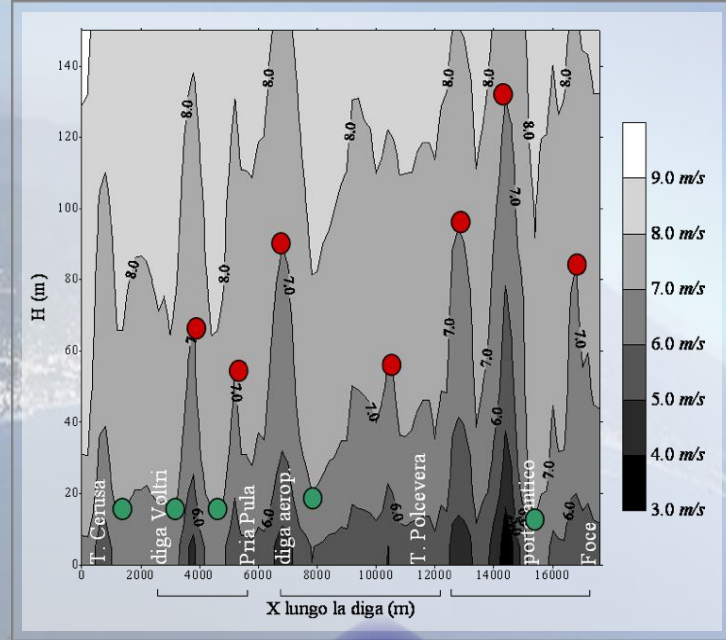
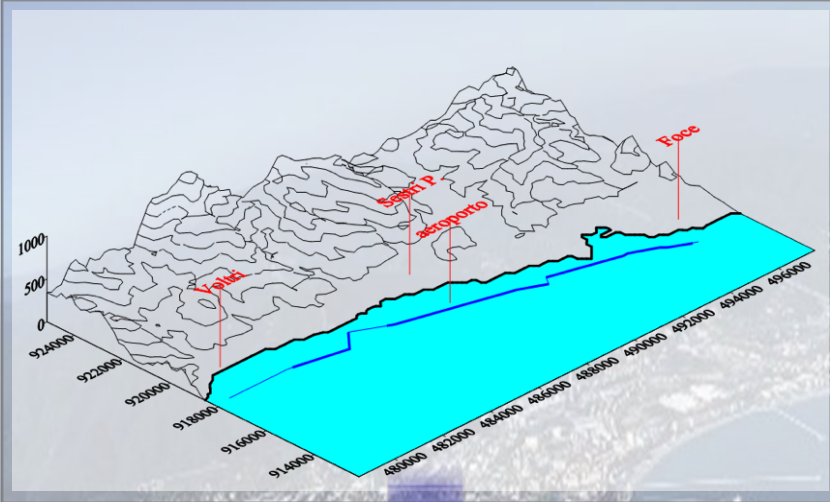


- Lower distance between wind turbines transversal to the main wind direction
- Higher linear density of wind power



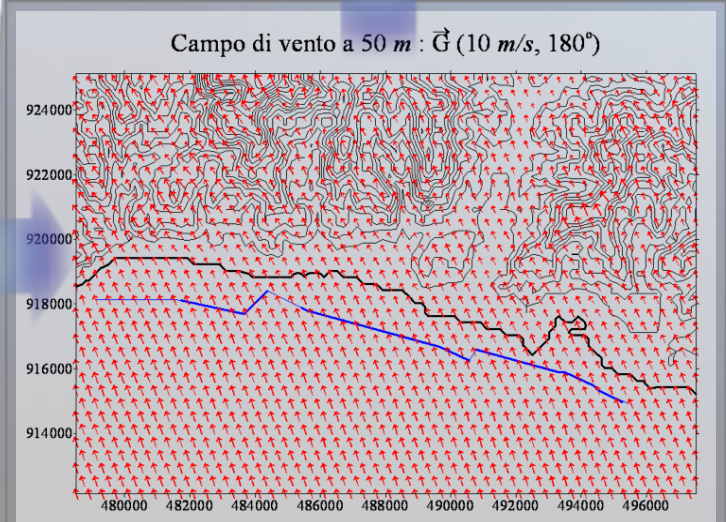
# Wind in coastal areas

Territory



Wind potential

Wind



Simulations



# Project “Vento e Porti”





# Project "Vento e Porti"

VENTO E PORTI - Home prova

Il Secolo XIX | Prima pagina del ... x VENTO E PORTI - Home prova x +

http://www.ventoeporti.net/public/default.asp

Google

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MARITTIMO - IT FR - MARITTIME  
TOSCANA - LIGURIA - SARDEGNA - CORSICA

*La Cooperazione al cuore del Mediterraneo*

Autorità Portuale di Genova  
 Autorità Portuale di Savona  
 DICAT  
 UNIVERSITÀ DI GENOVA

AP  
 Autorità Portuale della Spezia  
 Autorità Portuale di Livorno

Chambre de Commerce et d'Industrie de Bastia et de la Haute-Corse

**VENTO e PORTI**

LA PREVISIONE DEL VENTO PER LA GESTIONE E LA SICUREZZA DELLE AREE PORTUALI

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Home | Il Progetto | Porti | Sviluppo Attività | Documenti | Link | Eventi | Contatti |

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**VENTO e PORTI**

- GENOVA
- BASTIA
- LIVORNO
- SPEZIA
- SAVONA
- DICAT - Università di Genova  
*Attuatore Scientifico*

Timing

Divulgazione del progetto

Network

Modelli di previsione

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Programma cofinanziato con il Fondo Europeo di Sviluppo Regionale

Programme cofinancé par le Fonds Européen de Développement Régional

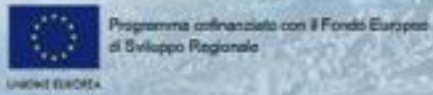
REGIONE TOSCANA

REGIONE LIGURIA

REGIONE AUTONOMA DELLA SARDEGNA



# Project "Vento e Porti"



La Cooperazione al cuore del Mediterraneo

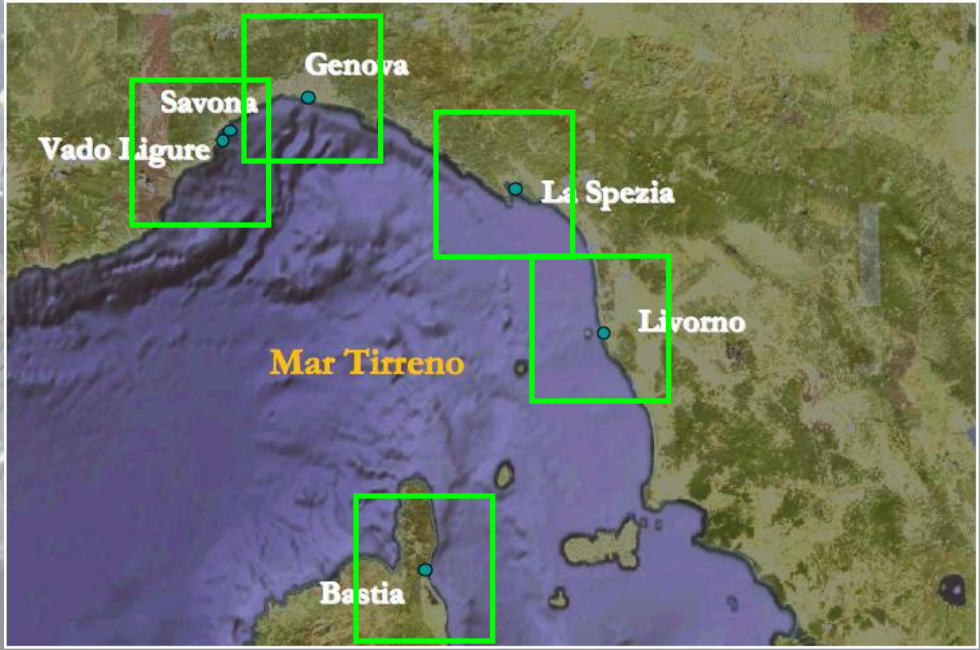


## VENTO e PORTI

LA PREVISIONE DEL VENTO PER LA GESTIONE E LA SICUREZZA DELLE AREE PORTUALI



3 years:  
July 2009 - June 2012





# Project "Vento e Porti"



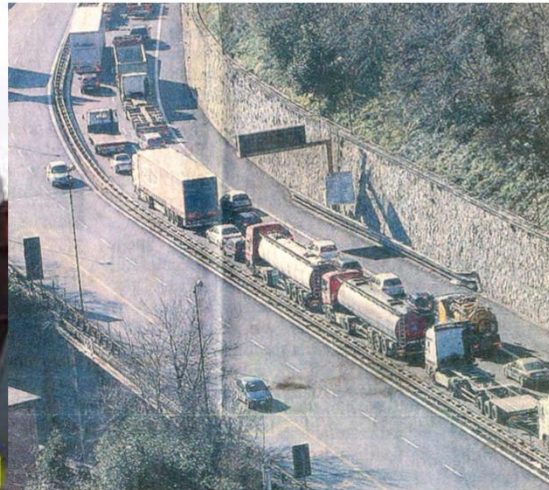


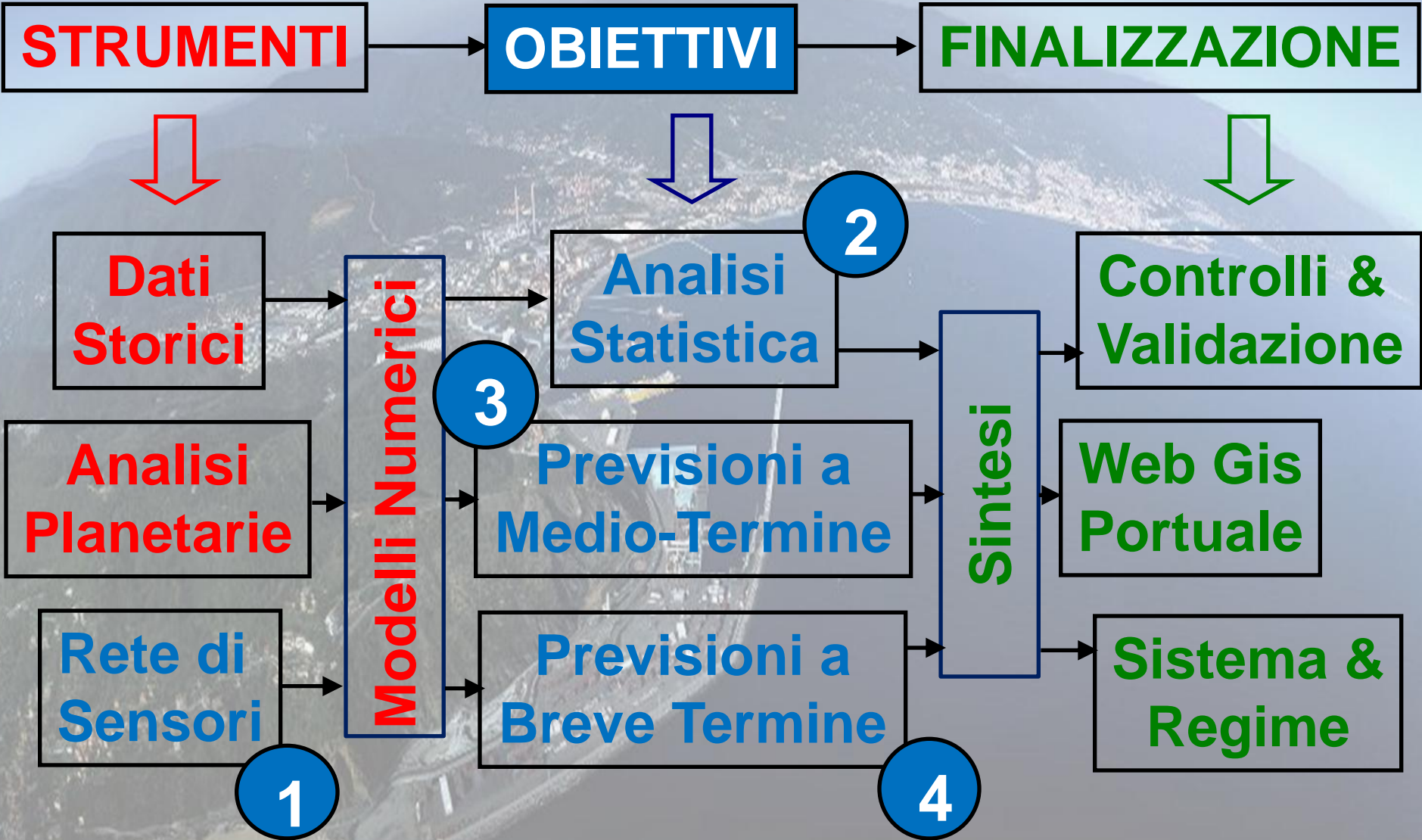
# Project "Vento e Porti"



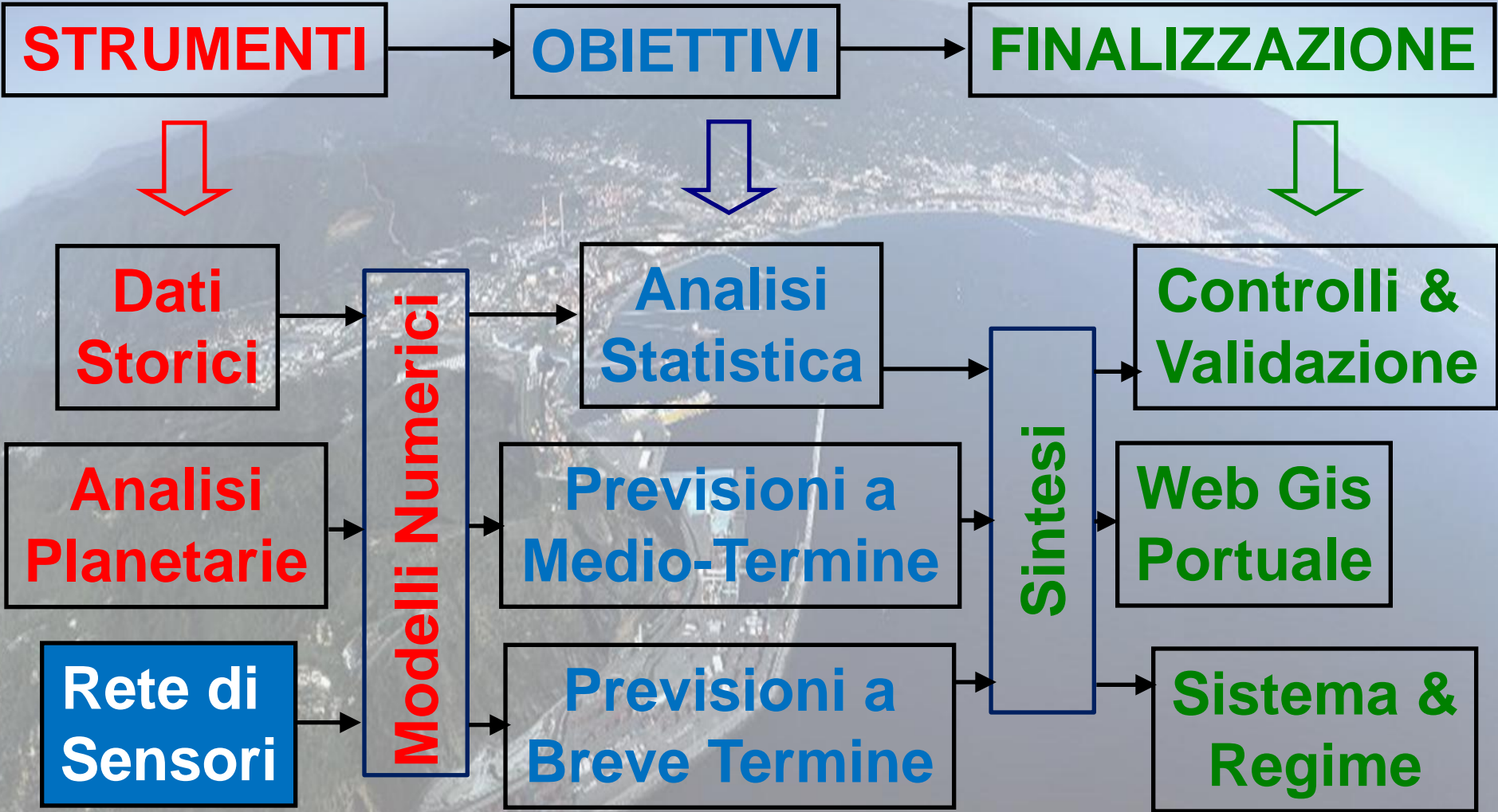
## «Basta paralisi in città»

File di Tir per lo stop dovuto al vento. Il vicesindaco: serve migliore informazione











# Biaxial Sonic Anemometer

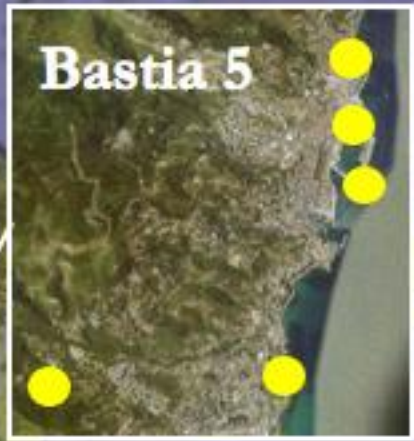


Triaxial Sonic Anem.



# Project "Vento e Porti"

**31 anemometri**





# Project "Vento e Porti"



Anemometro 1:  
Torre Piloti,  
molo Giano

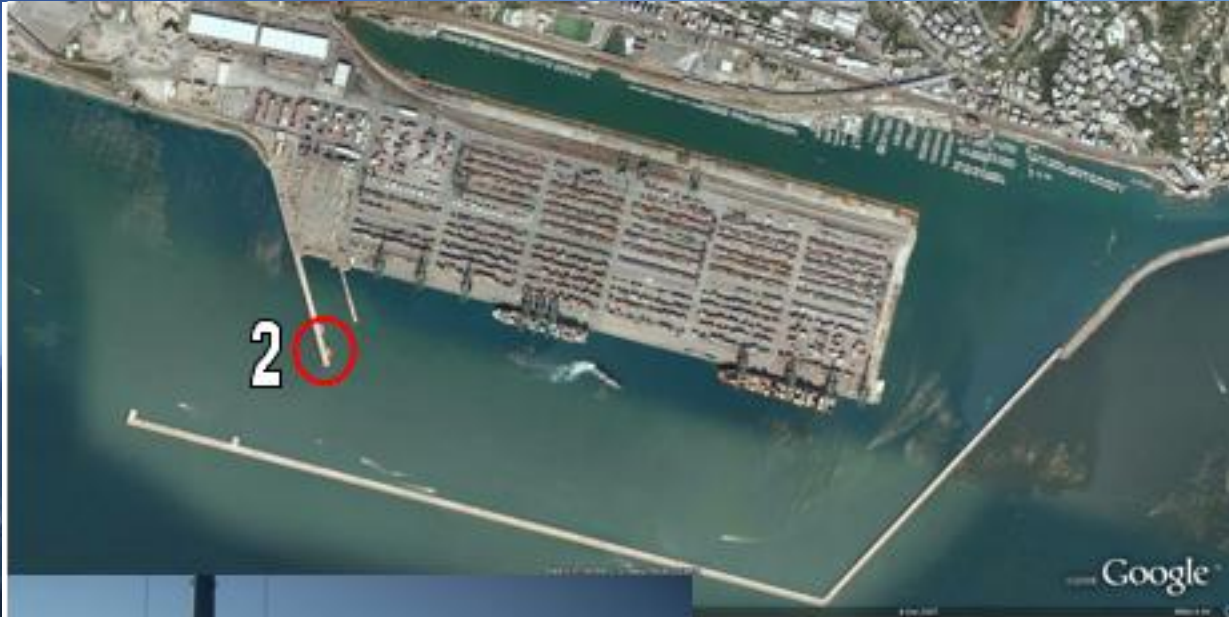


Porto di Genova





# Project "Vento e Porti"



Anemometro 2:  
molo di Voltri



Porto di Genova



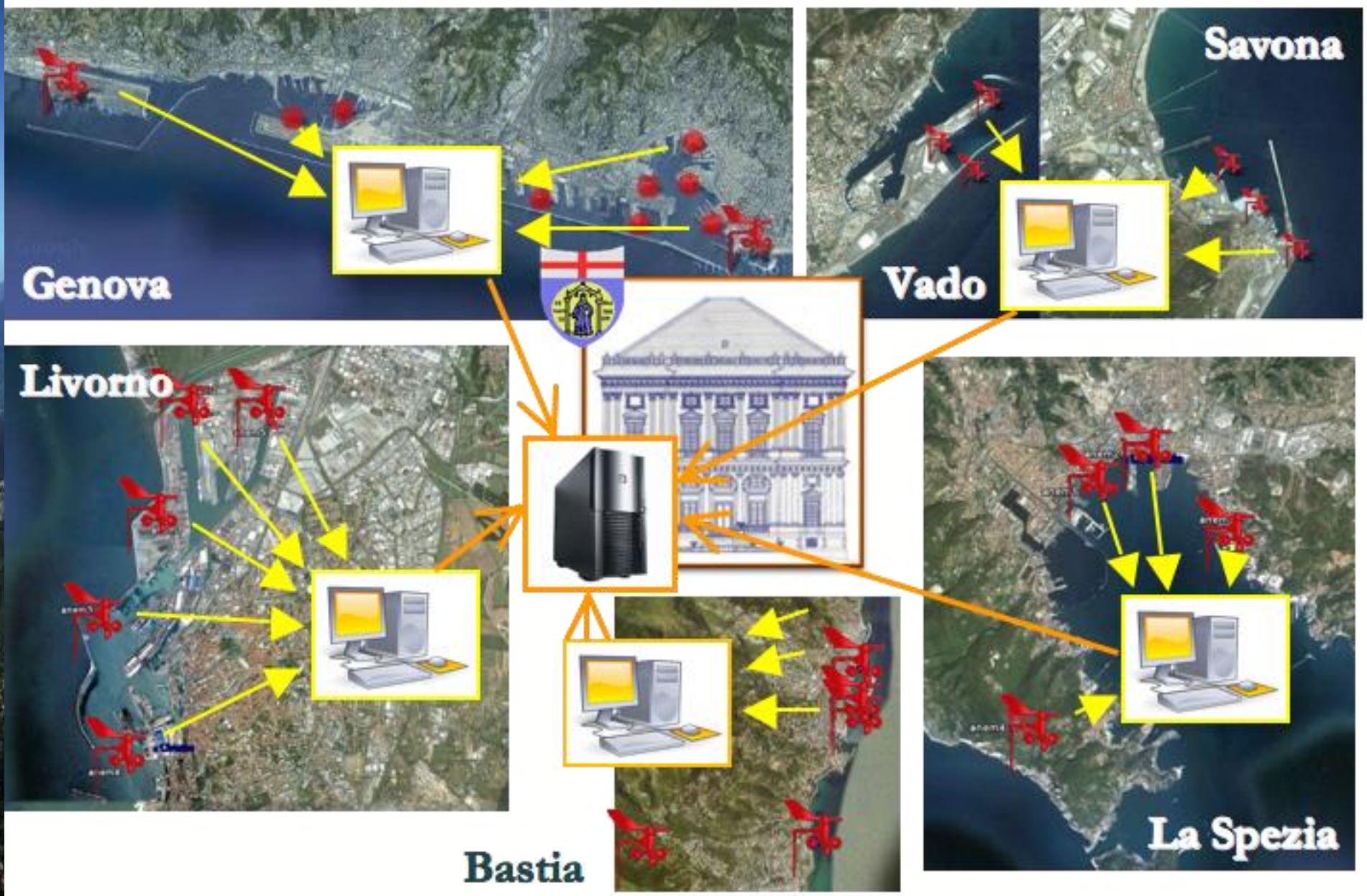


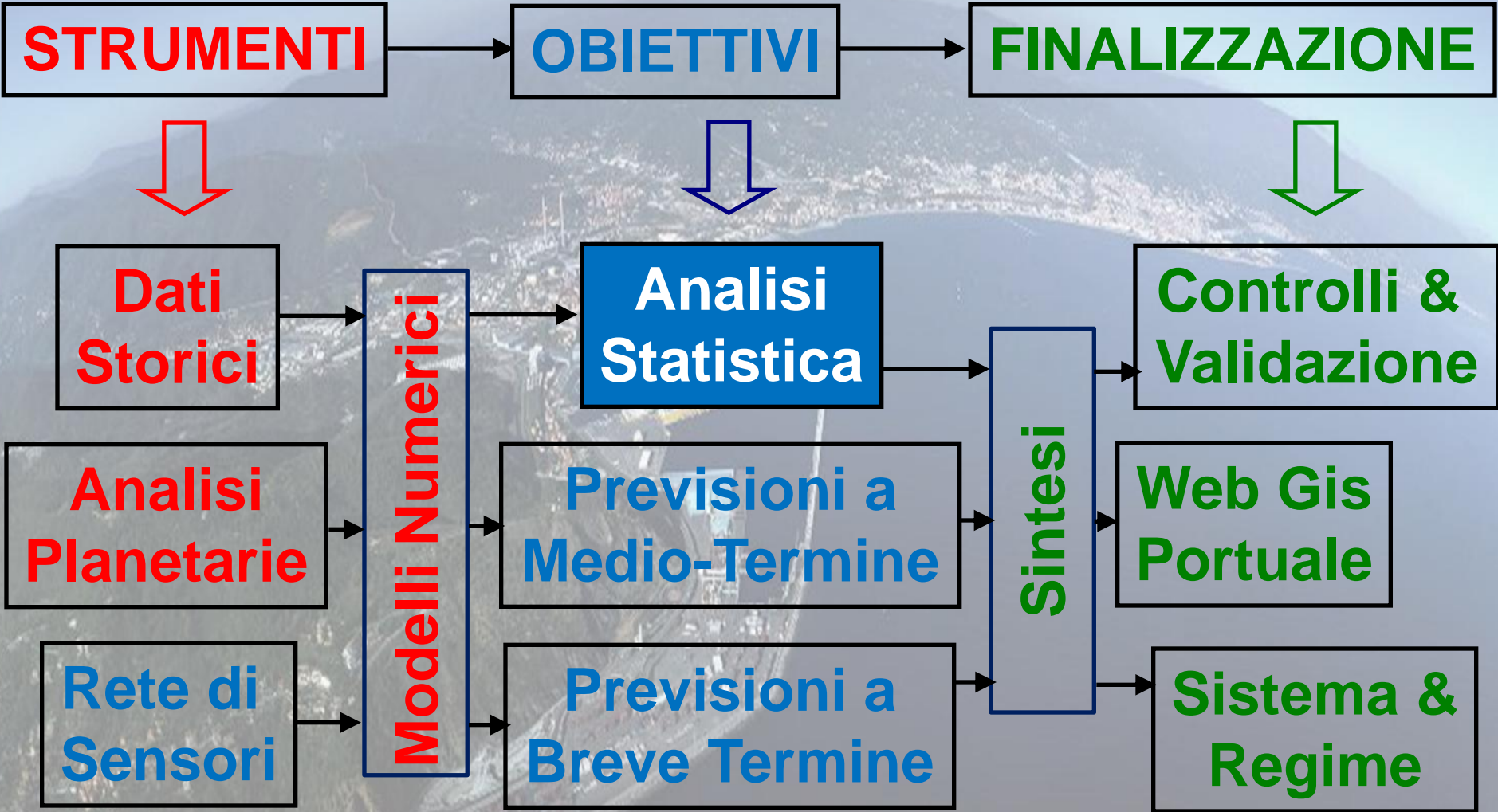
# Project "Vento e Porti"





# Project "Vento e Porti"

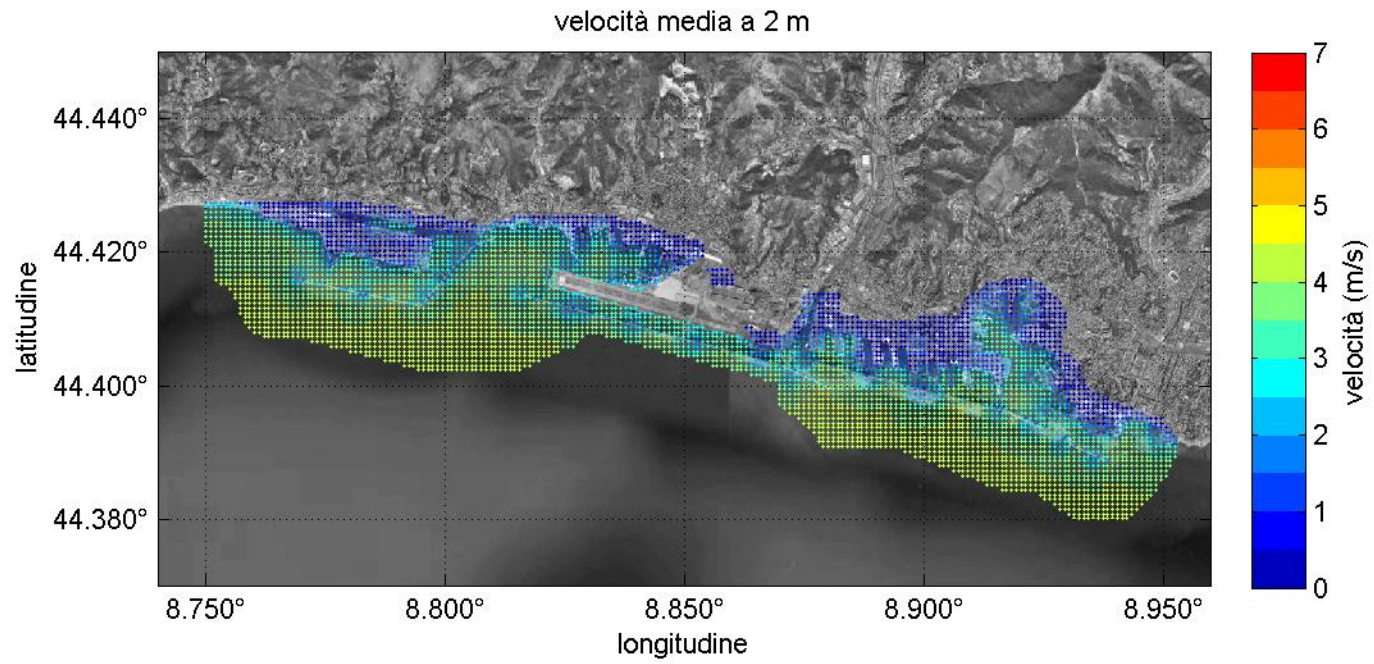






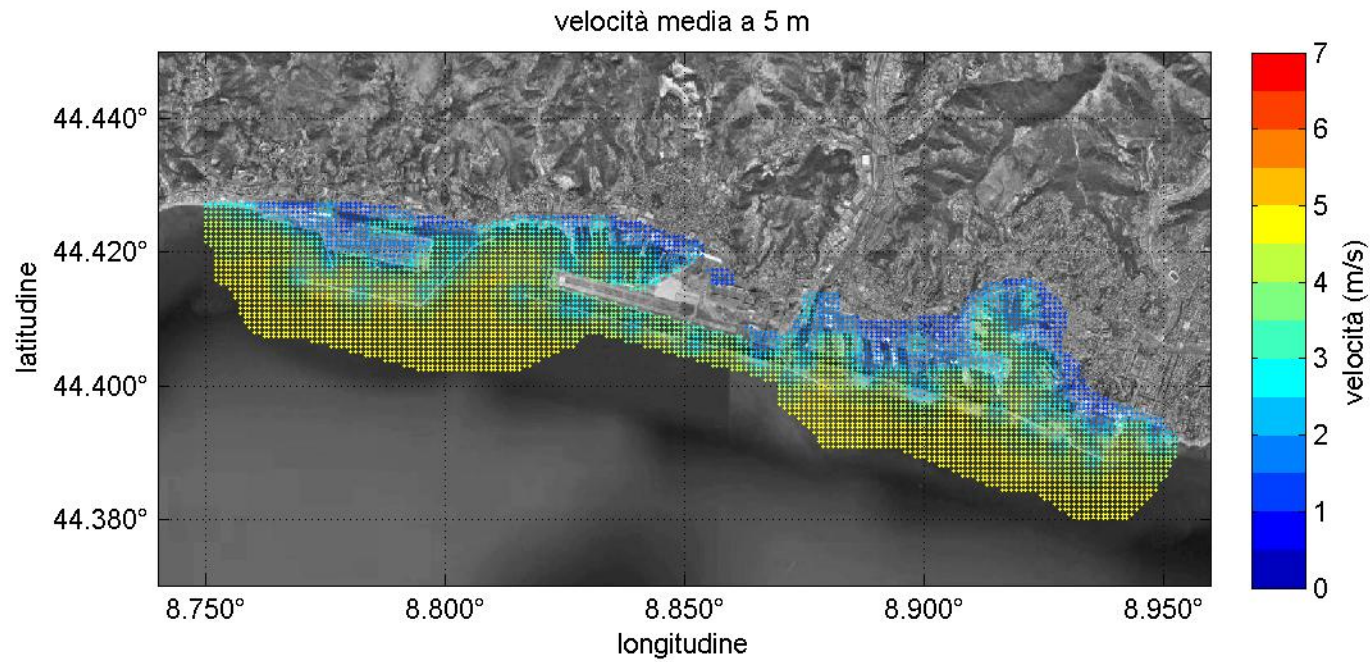


# Project "Vento e Porti"



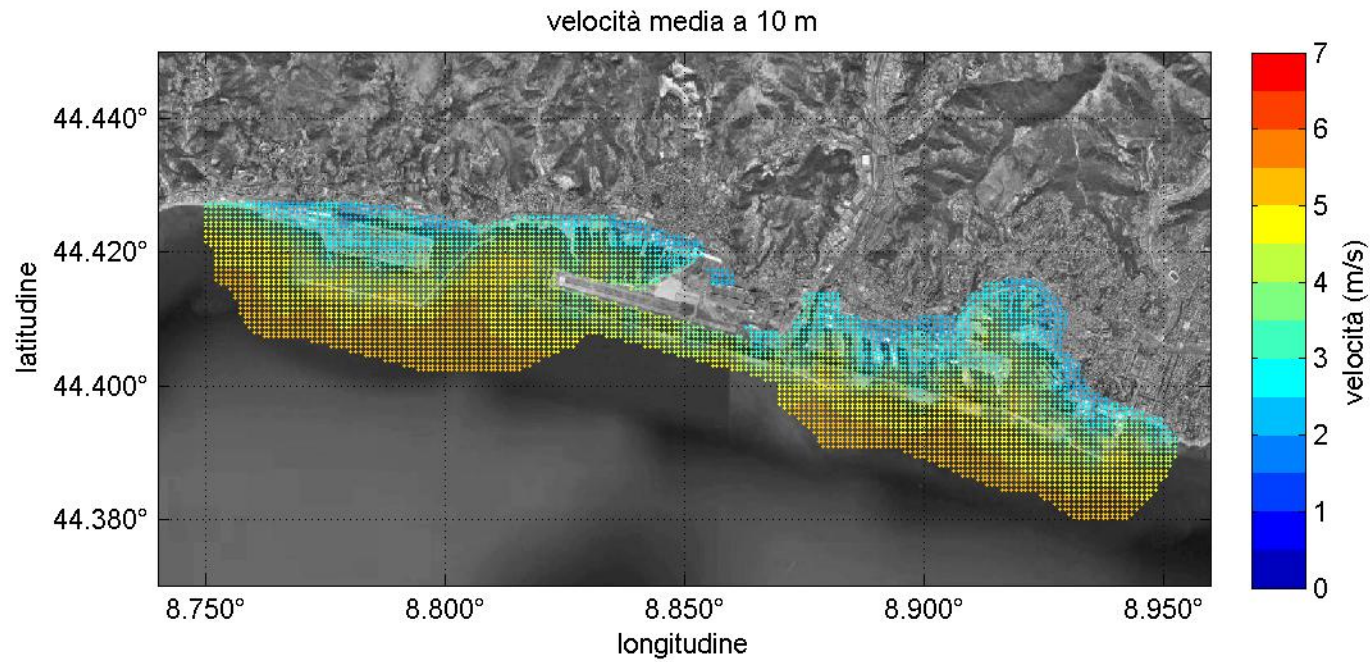


# Project "Vento e Porti"



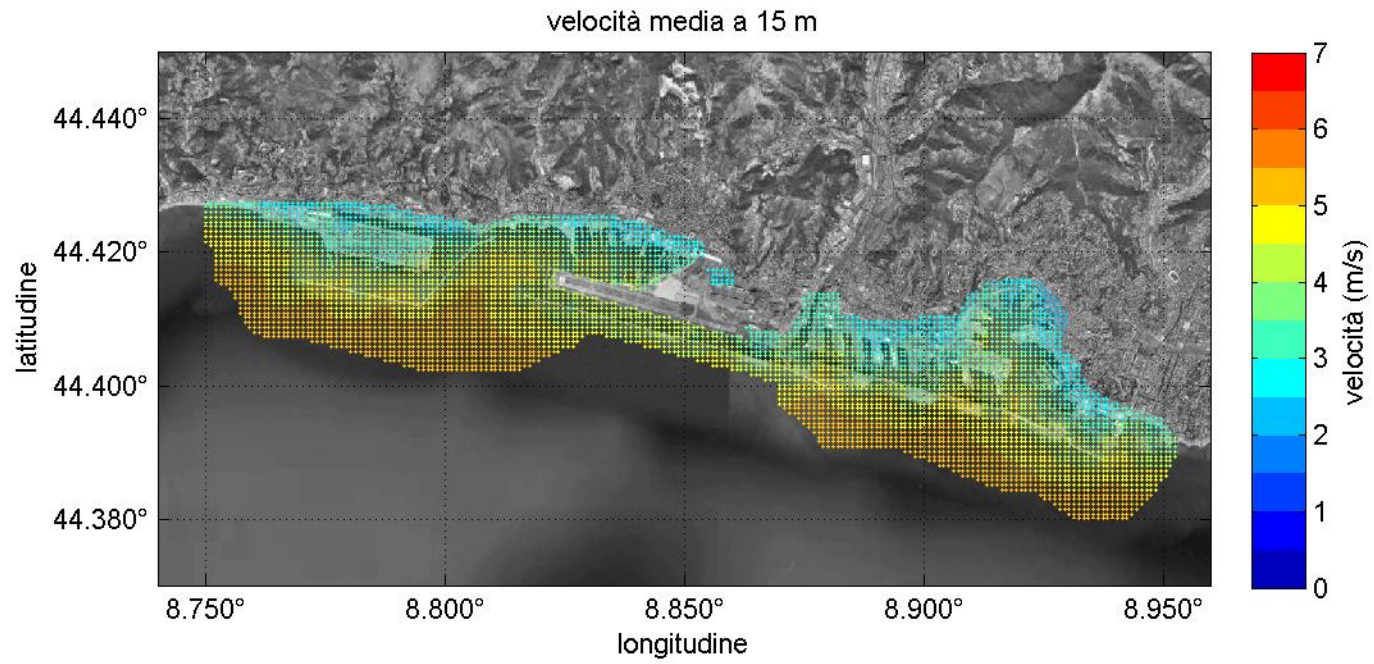


# Project "Vento e Porti"



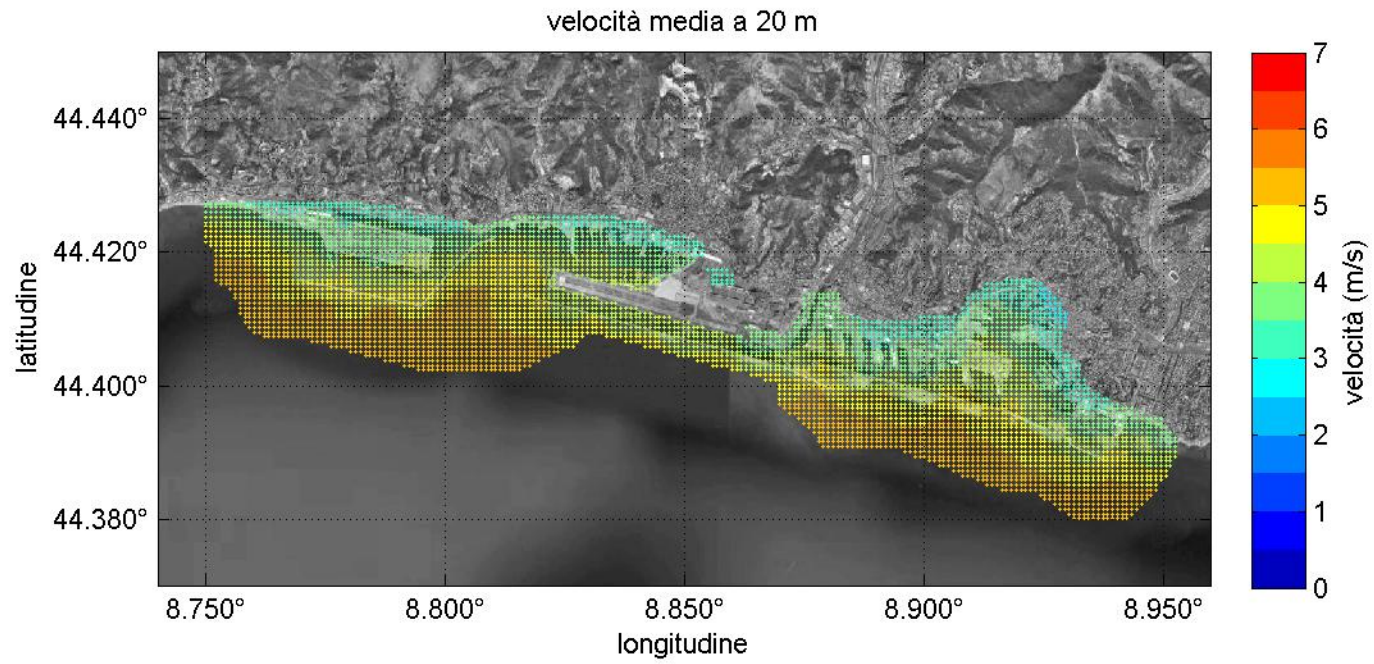


# Project "Vento e Porti"



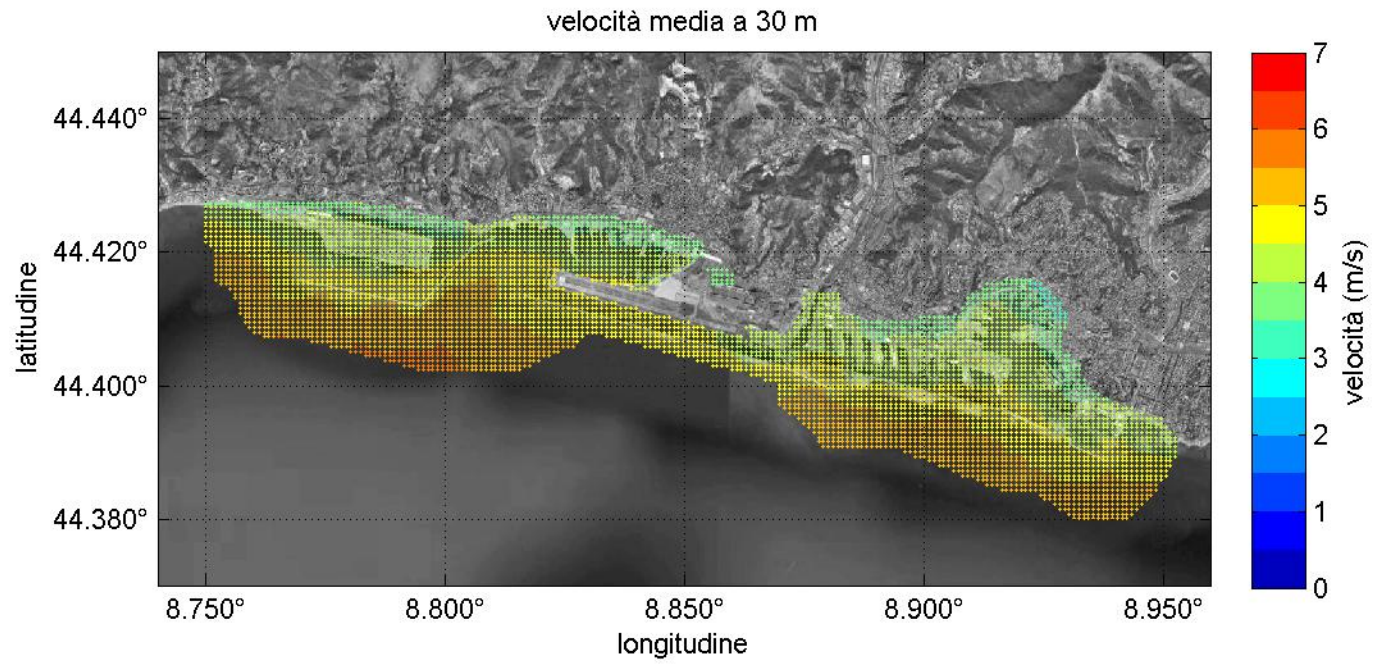


# Project "Vento e Porti"



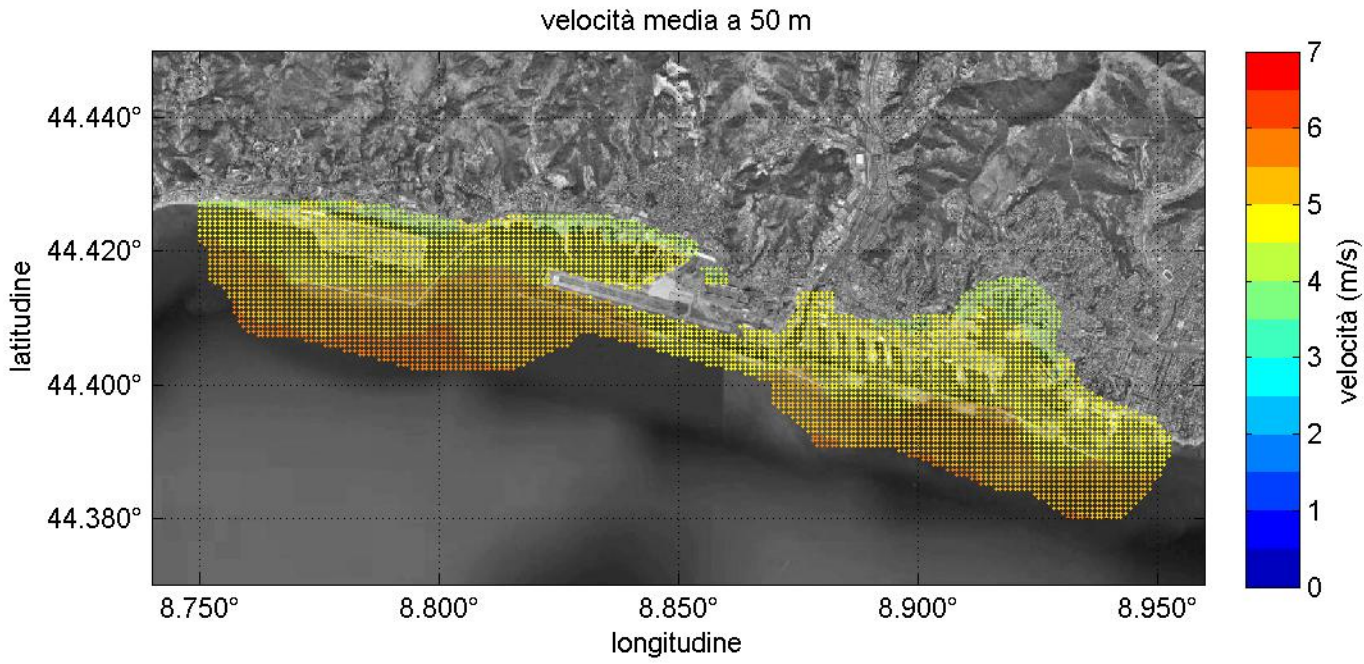


# Project "Vento e Porti"



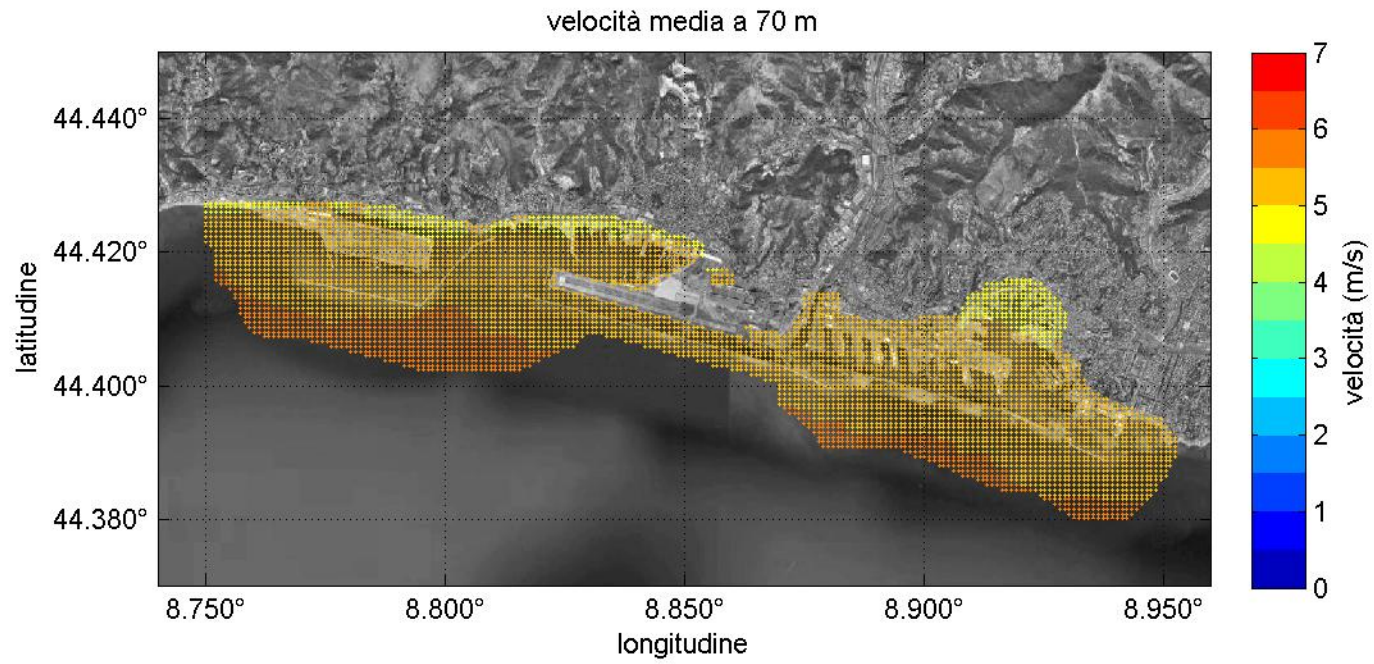


# Project "Vento e Porti"





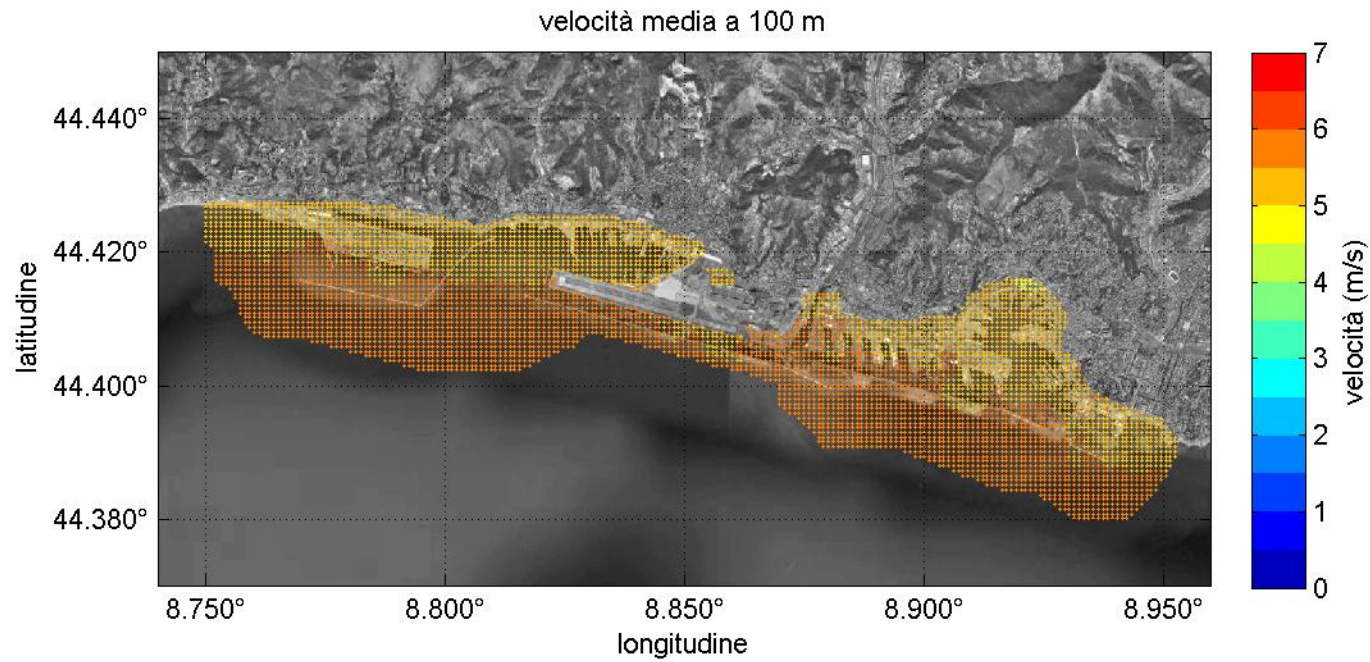
# Project "Vento e Porti"





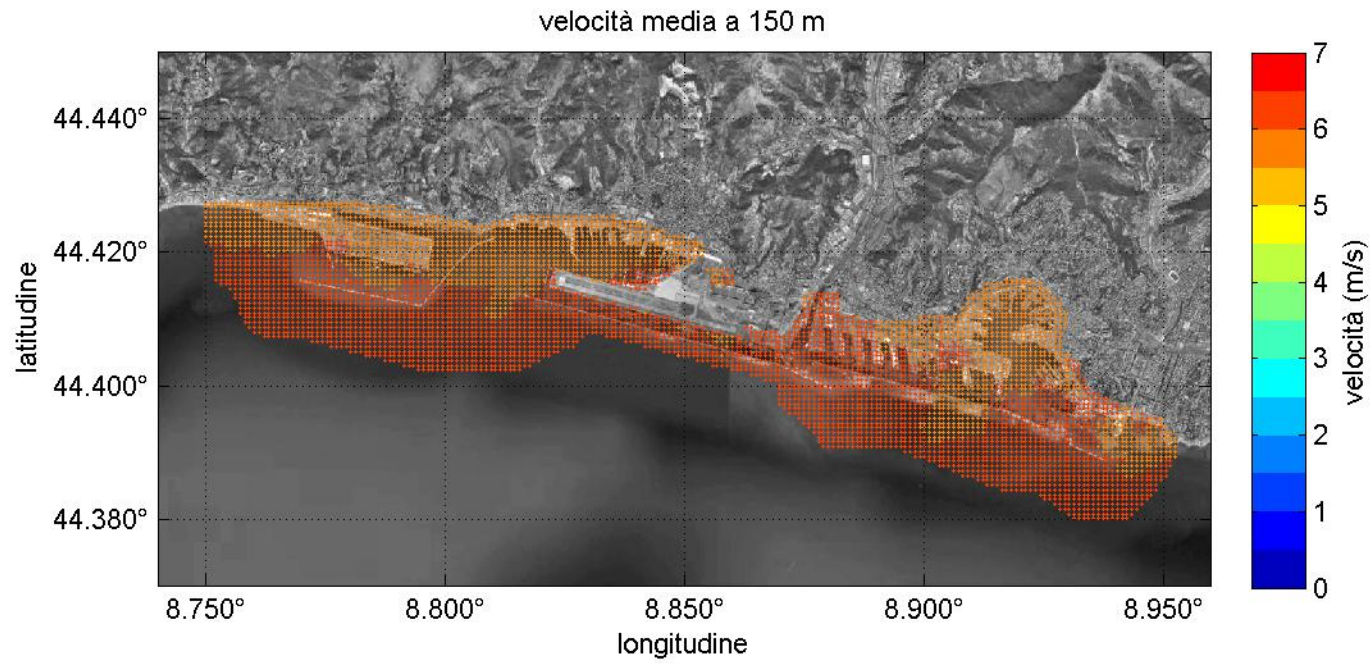


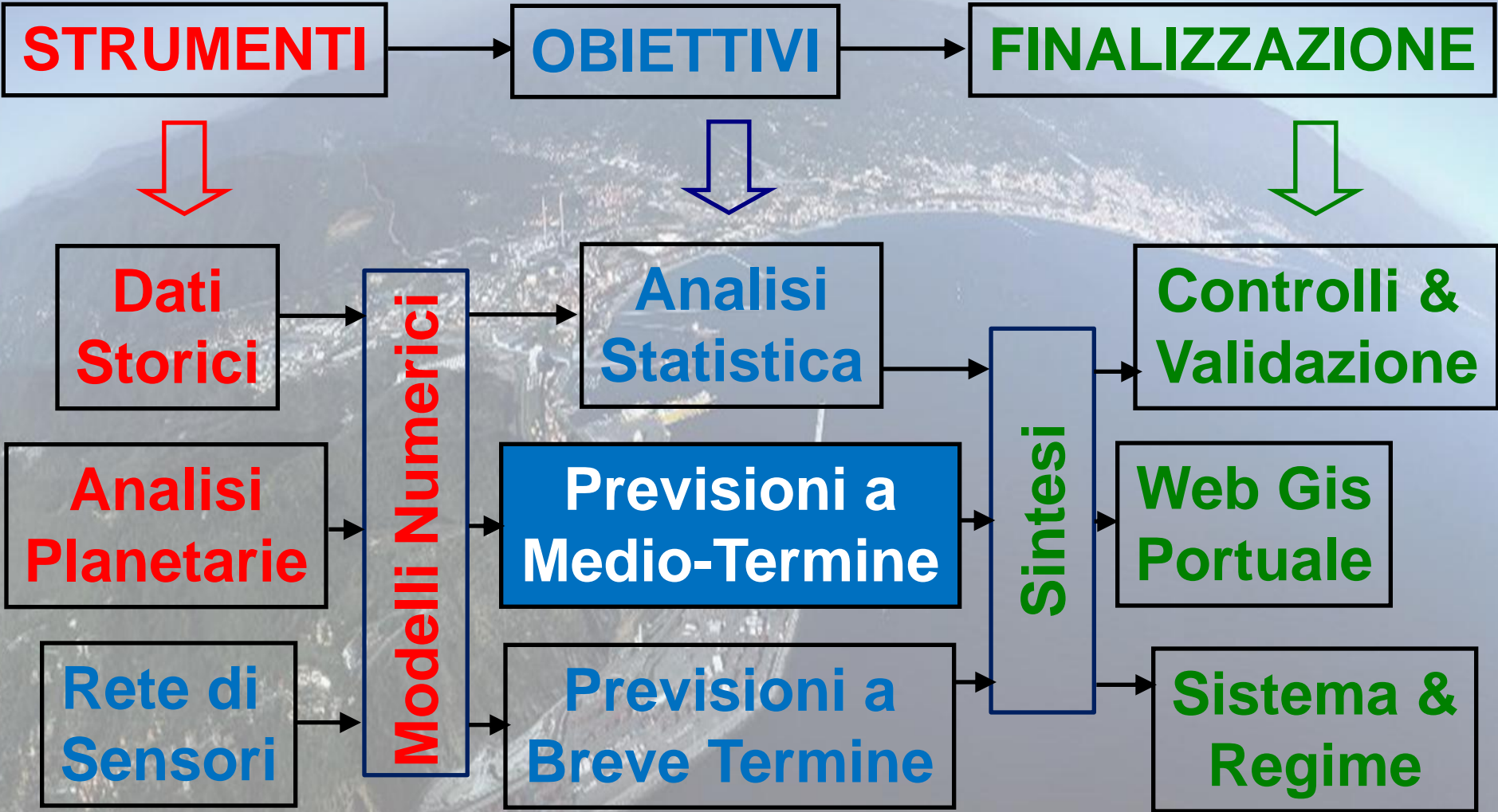
# Project "Vento e Porti"





# Project "Vento e Porti"

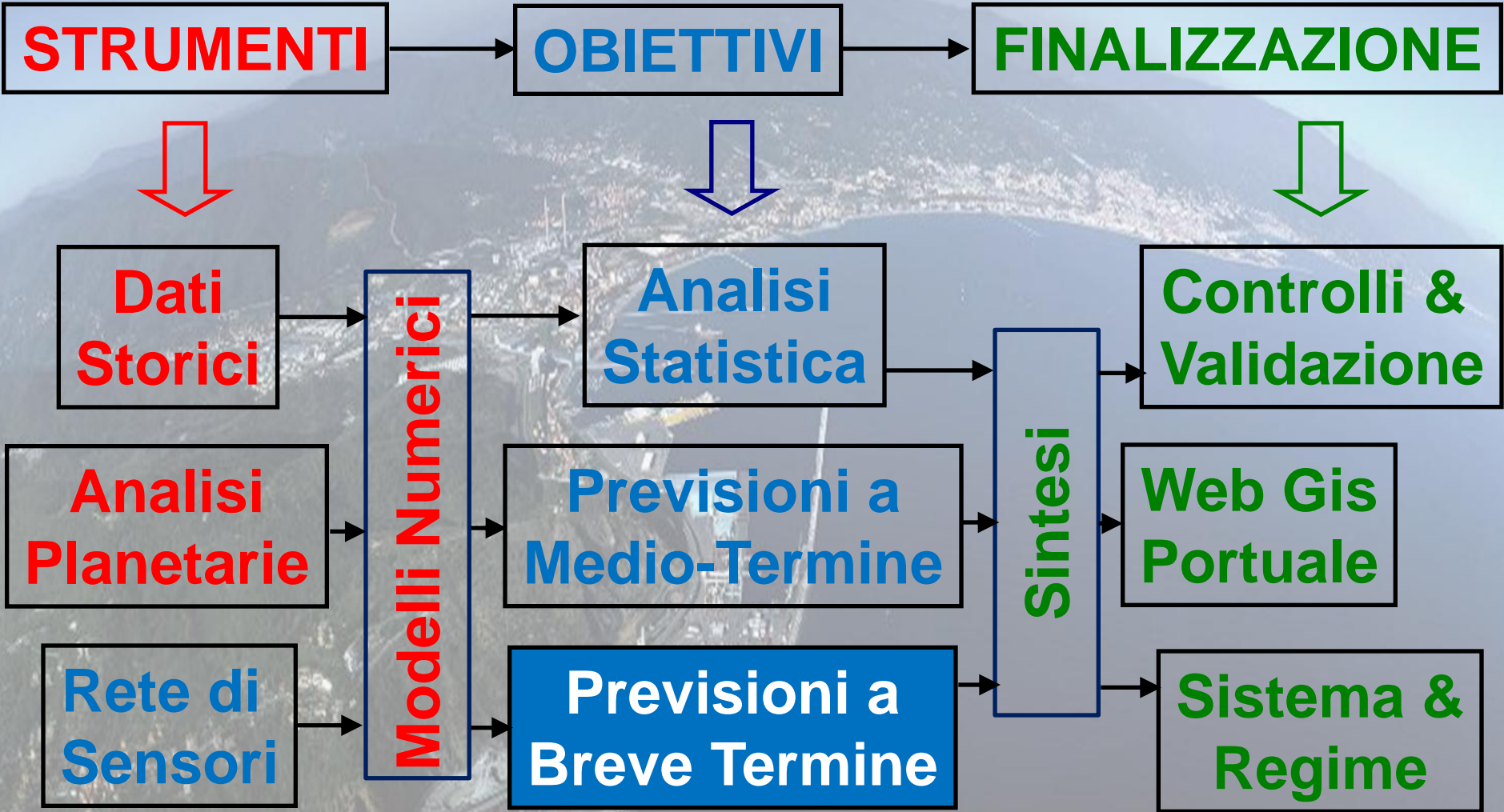






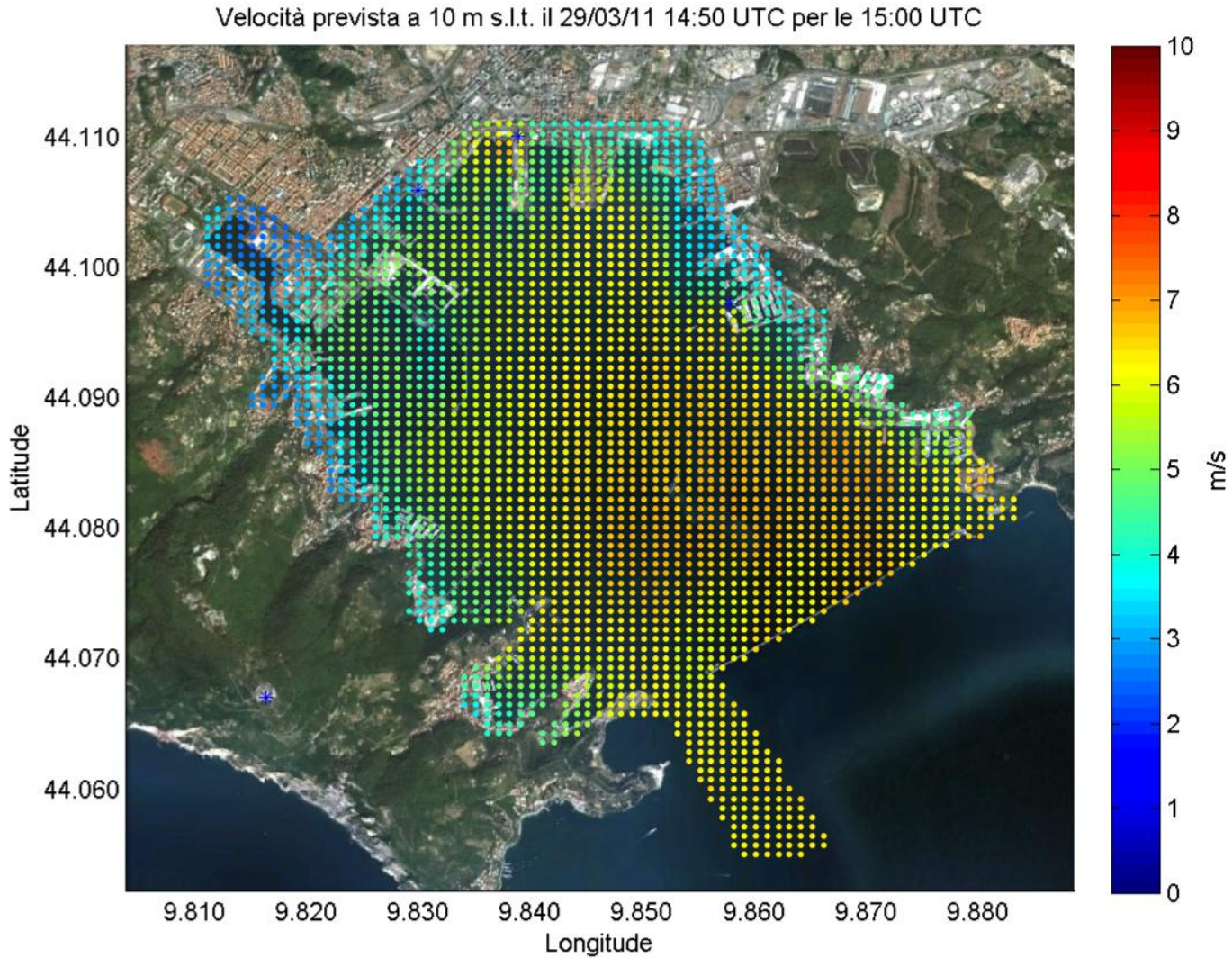
**Forecast of the Genoa's flooding — 4-6 November 2011**





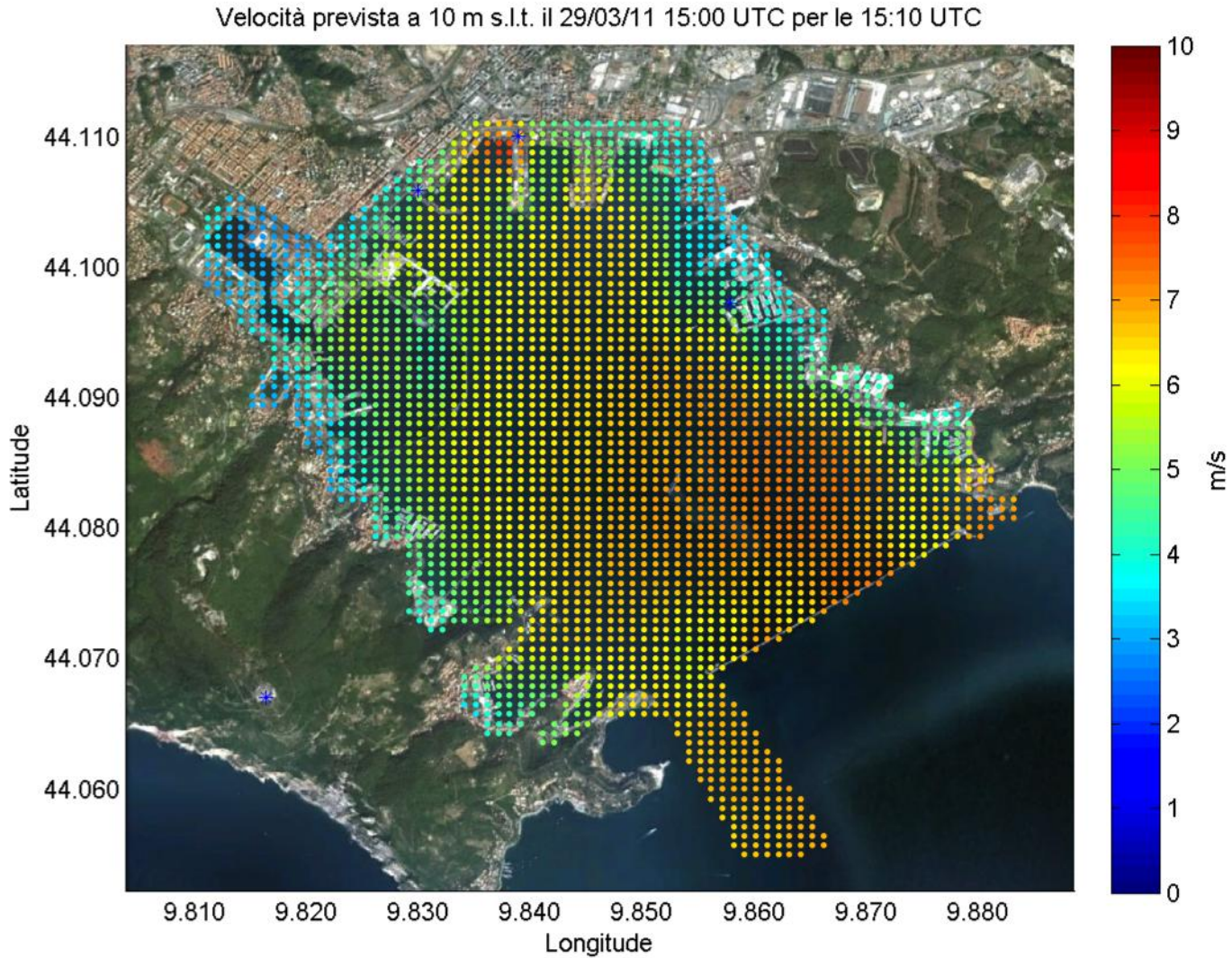


# La Spezia – 29/3/2011 – 15:00 UTC – $z = 10$ m





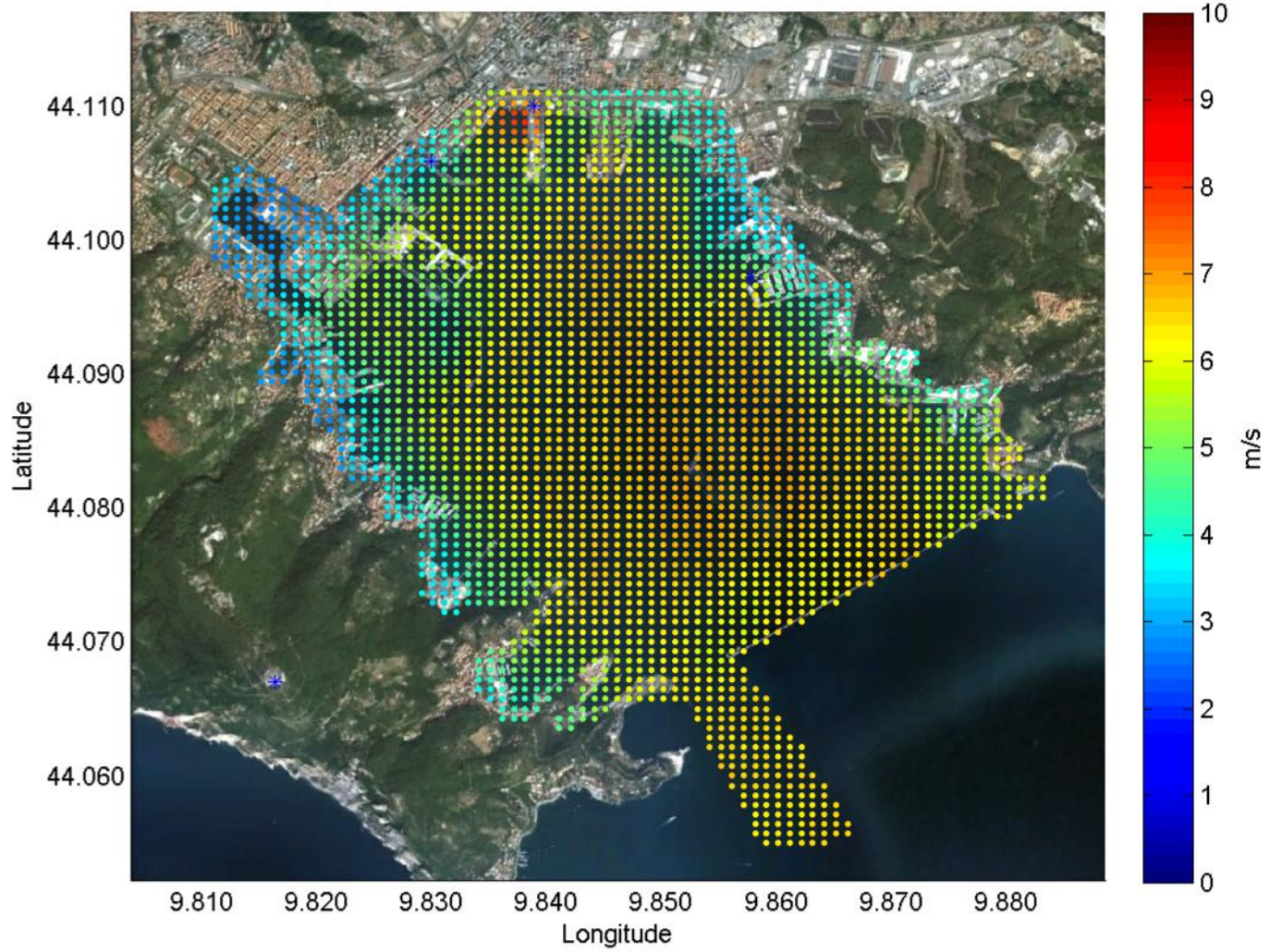
# La Spezia – 29/3/2011 – 15:10 UTC – $z = 10$ m





# La Spezia – 29/3/2011 – 15:20 UTC – z = 10 m

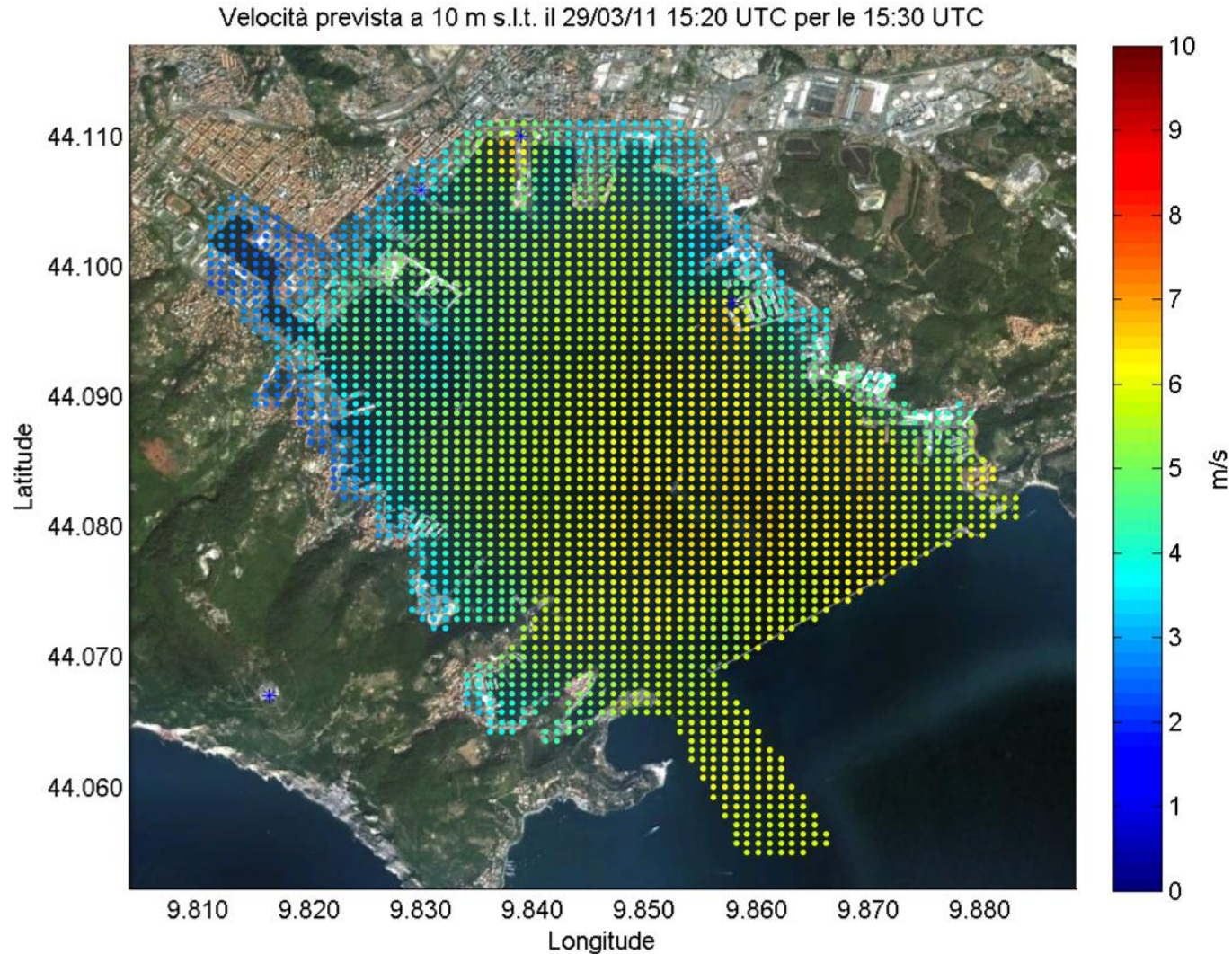
Velocità prevista a 10 m s.l.t. il 29/03/11 15:10 UTC per le 15:20 UTC





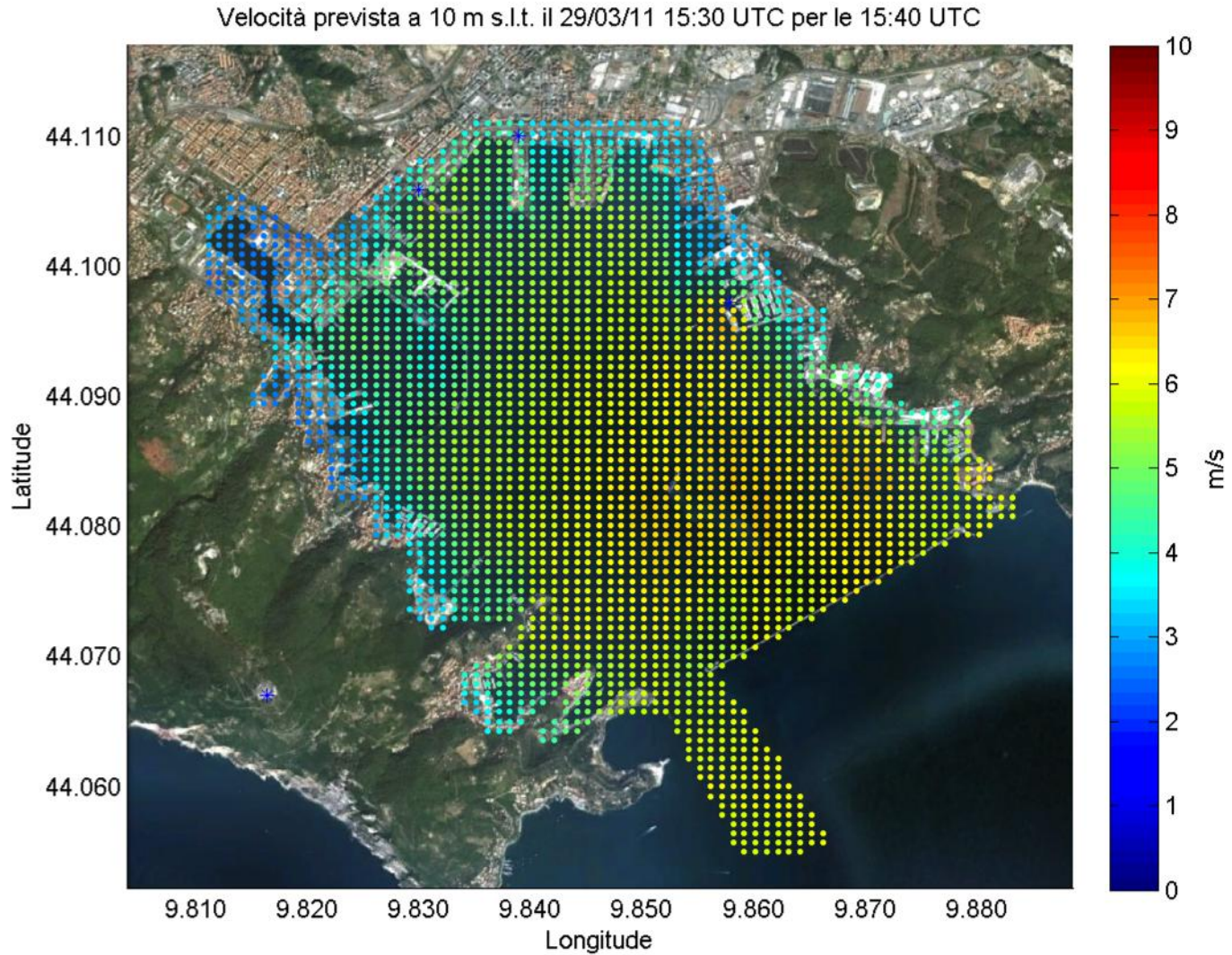


# La Spezia – 29/3/2011 – 15:30 UTC – $z = 10$ m



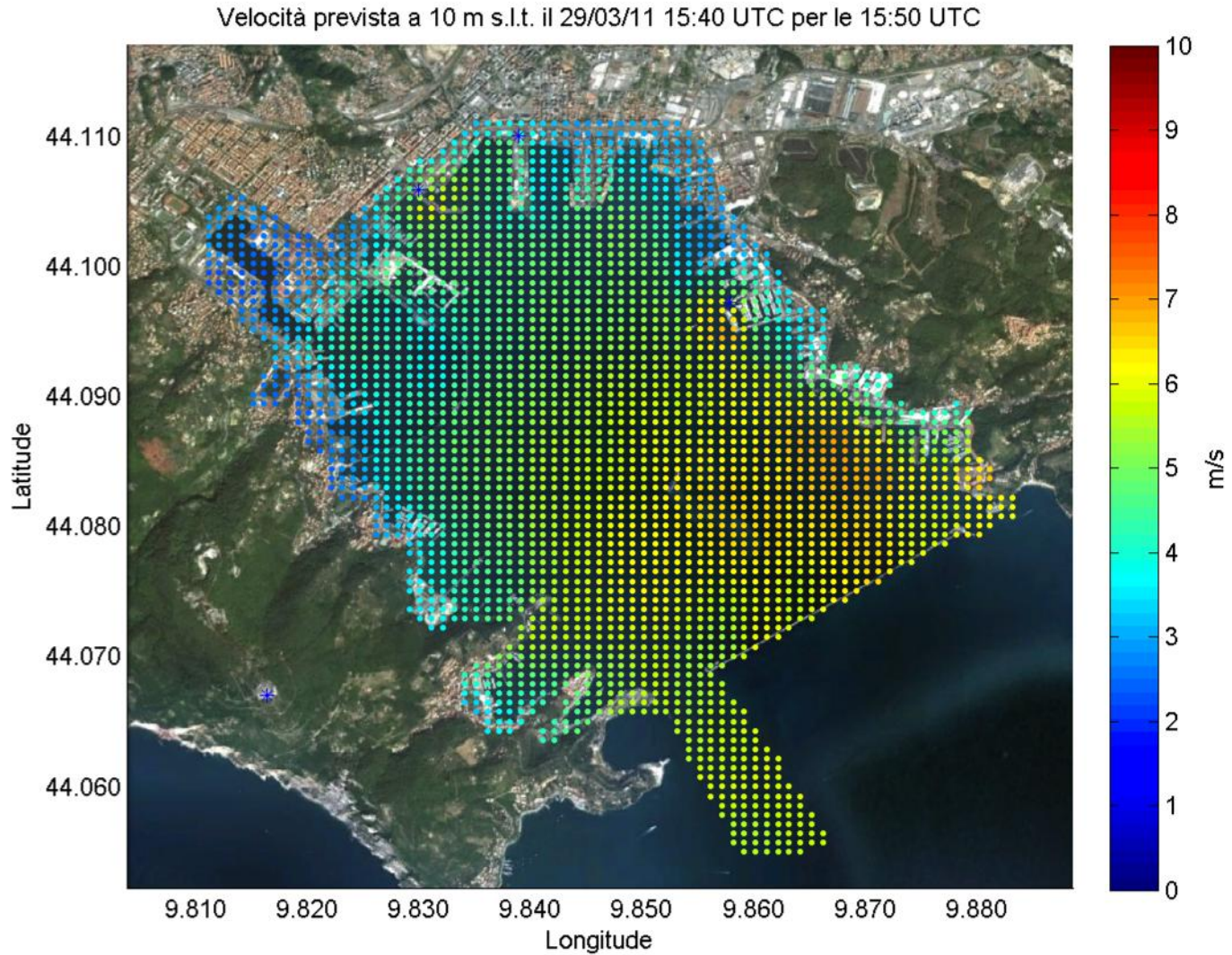


# La Spezia – 29/3/2011 – 15:40 UTC – $z = 10$ m



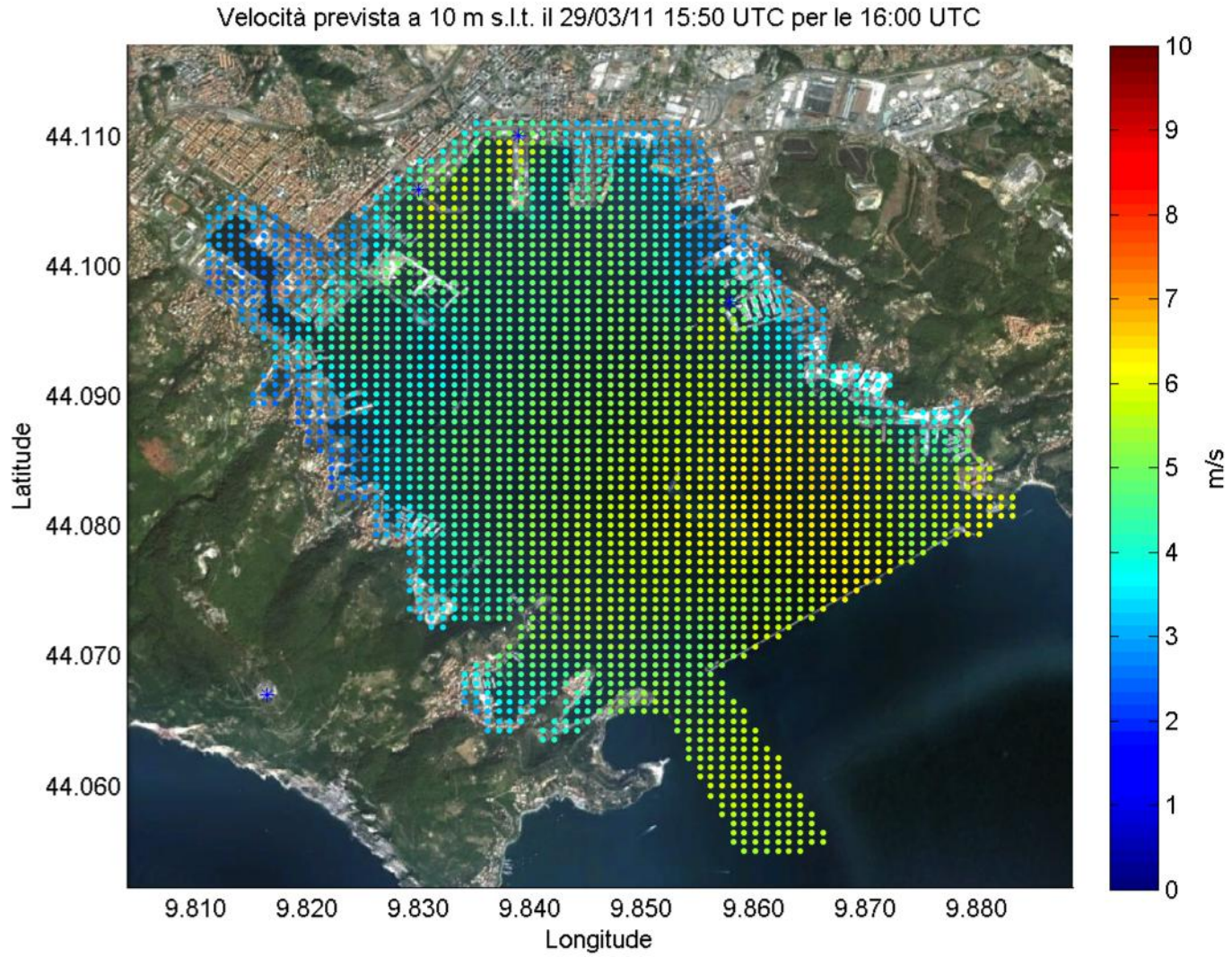


# La Spezia – 29/3/2011 – 15:50 UTC – $z = 10$ m





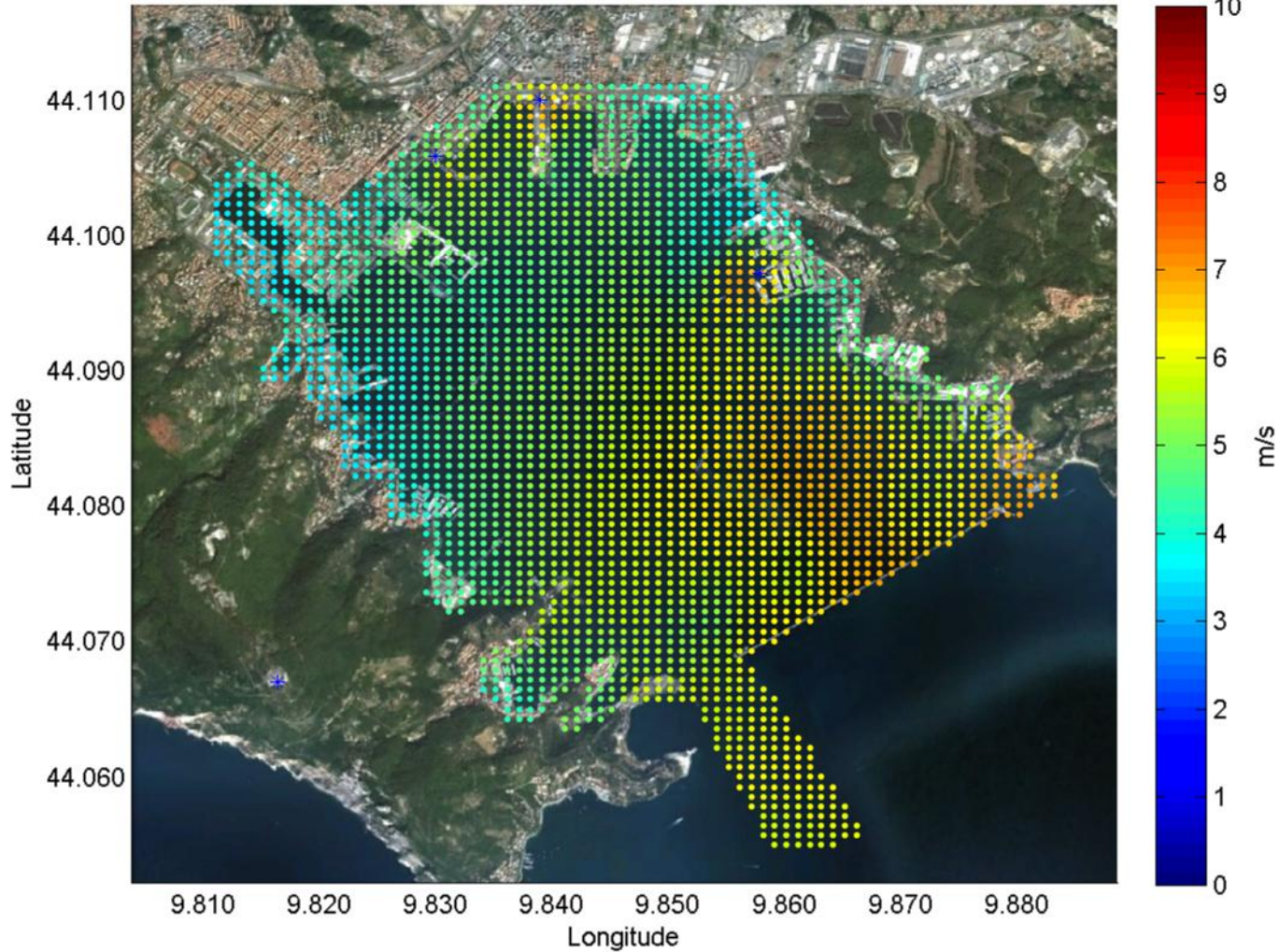
# La Spezia – 29/3/2011 – 16:00 UTC – $z = 10\text{ m}$





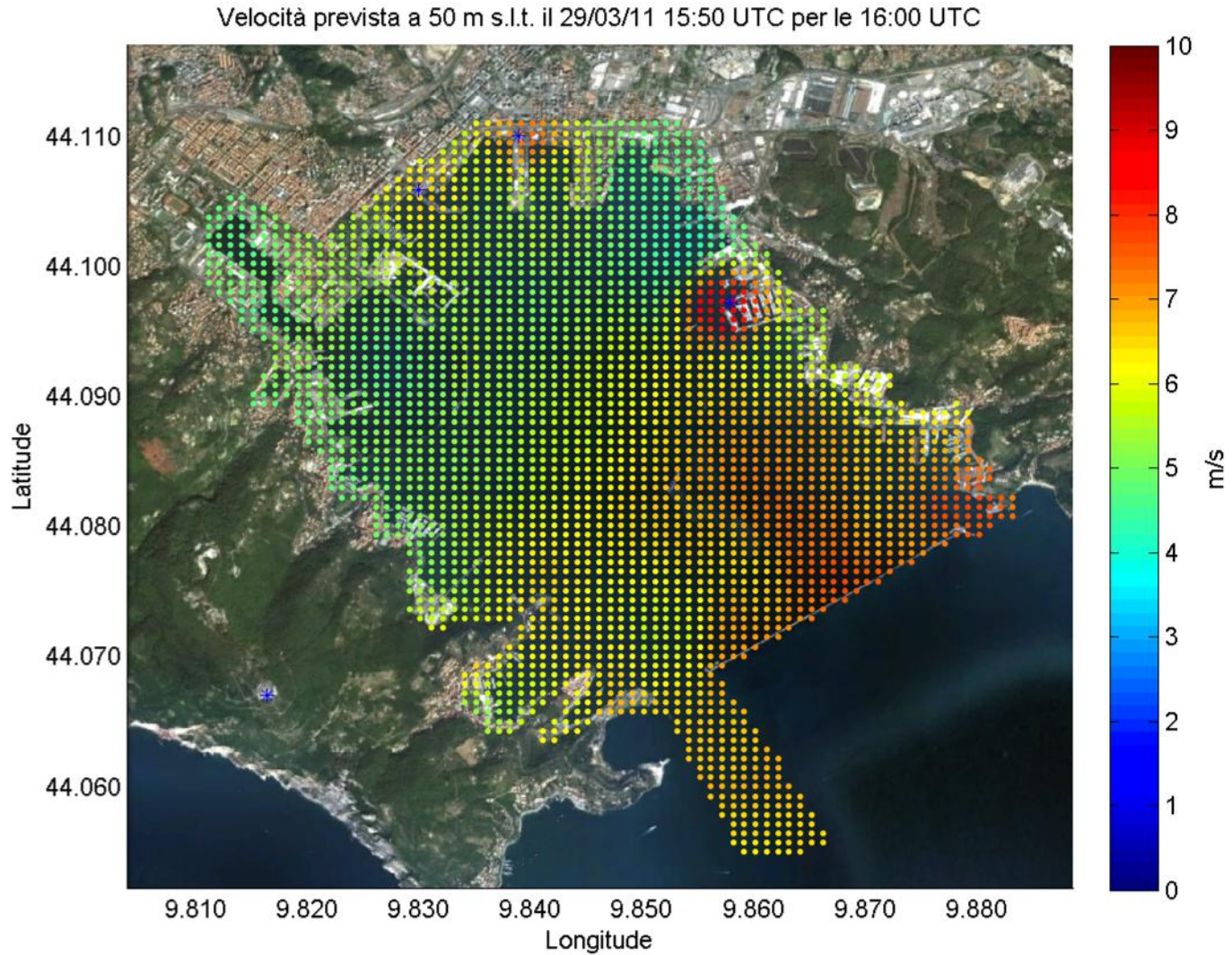
# La Spezia – 29/3/2011 – 16:00 UTC – $z = 20$ m

Velocità prevista a 20 m s.l.t. il 29/03/11 15:50 UTC per le 16:00 UTC





# La Spezia – 29/3/2011 – 16:00 UTC – $z = 50$ m





- **Statistics can be used for wind farm design**
- **Medium-term forecast can be used to estimate wind energy production (also to a longer temporal horizon and in ensemble configuration)**
- **Short-term forecast can be used to sell energy for the day-ahead electricity market or intra-day markets**



# Conclusions







# Conclusions

- Offshore wind turbine technology is getting to maturity: fixed foundations and floating technology allow nowadays wind energy exploitation at deeper and deeper sea





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Dipartimento di Ingegneria delle Costruzioni, dell'Ambiente e del Territorio



# GRAZIE

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Green Ports - Genova, 10-11 Novembre 2011