



SPECIAL VERIFICATION APPLICATION: OPERATIONAL WIND VERIFICATION OVER NORTH ADRIATIC SEA

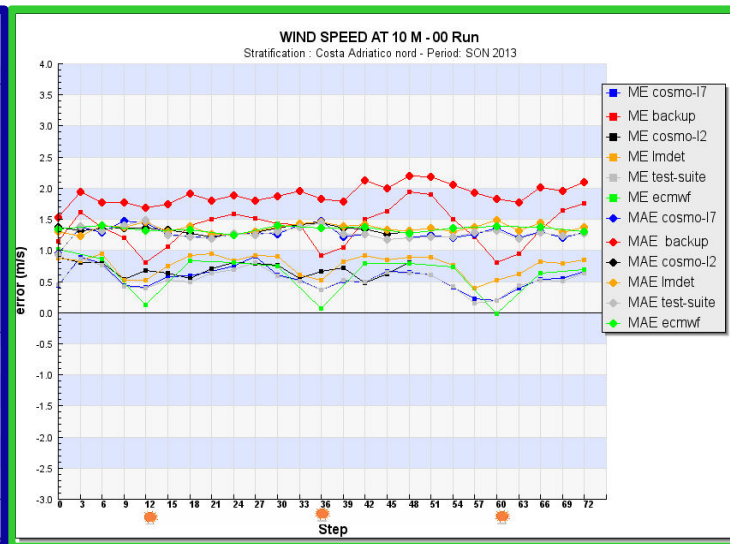
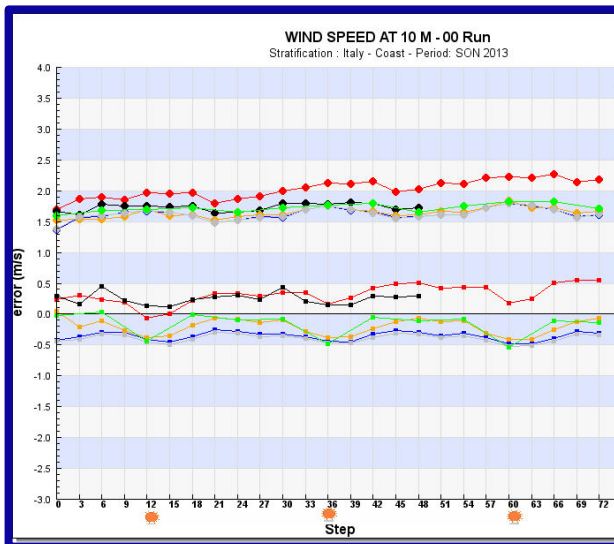
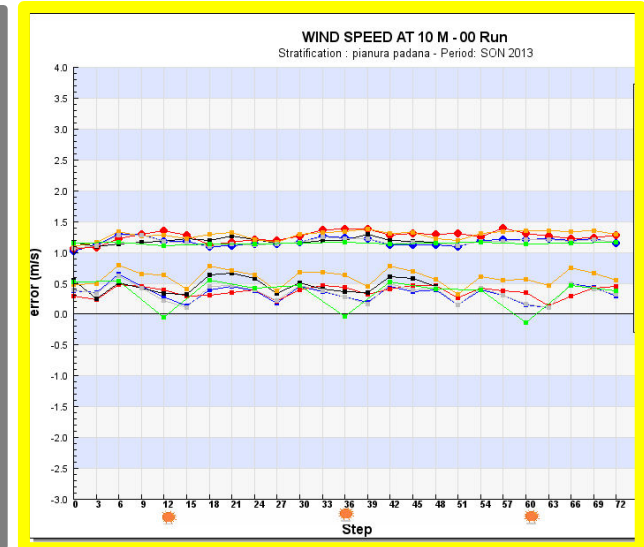
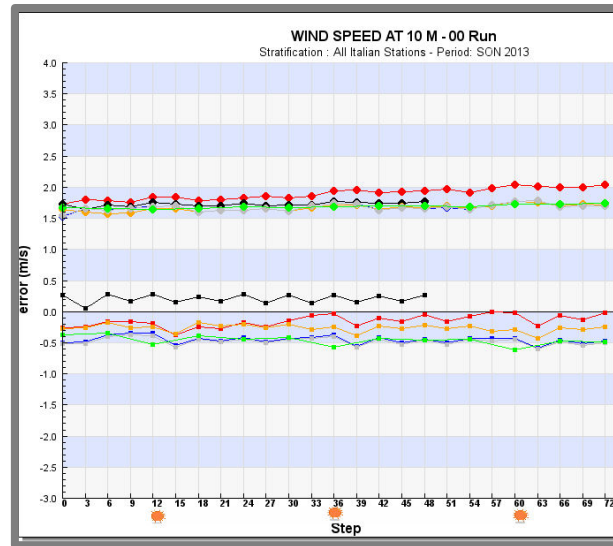
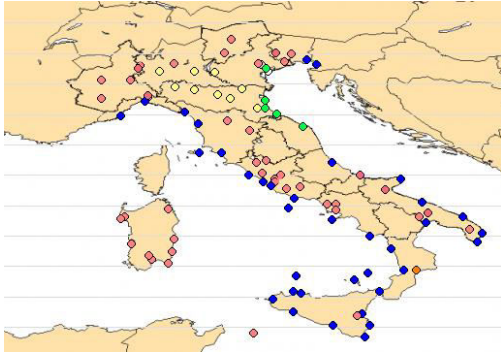
Maria Stefania Tesini

16th COSMO General Meeting
8-11 September 2014, Eretria (Greece)

Outline

- Some preliminary results of a work that has been done for a end-user of numerical forecast of wind field are presented
- Standard verifications techniques are used, but they are not sufficient to satisfy the request of the user for a better use of models forecasts
- Different ways of depict wind speed and direction are investigated, some results are presented as examples of the properties that can be deduced from the plots

10 m wind speed verification over Italy



But for most practical application these information are not enough!

One of the applications: meteorological support for MOSE

MOSE

To protect Venice and its lagoon from high waters

HOME THE MOSE NOT JUST MOSE VISITS WEBCAM GALLERY VIDEO NEWS PRESS CONTACTS YouTube

THE MOSE

Why

Where

How

The worksites

The project in figures

Who

Mose in the Arsenal

(Italiano) Il Mose nel mondo

Insights



Livello raggiunto dalla marea il 4 novembre 1966

Gallery

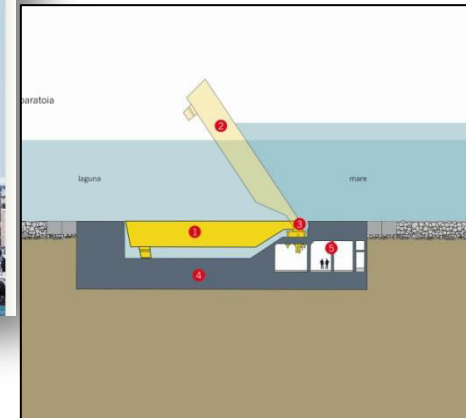


WHY

Since the beginning of the 1900s, high waters have becoming ever more frequent as the land has dropped and sea level has risen. The floods cause inconvenience to inhabitants and damage to architecture and buildings. There is also an ever present risk of a catastrophic event such as the 4 November 1966 flood when Venice, Chioggia and other built up areas in the lagoon were completely submerged under more than a metre of water.



Mose defends Venice and the lagoon from tides up to 3 m high and from a rise in sea level of up to 60 cm over the next 100 years; it protects against a catastrophic event (no-one knows when, but sooner or later it will happen); it eliminates the inconvenience and financial damage caused by the most frequent high waters and it enables the quality of life in general to be improved, revaluating ground floors and diversifying the intended use, including with the establishment of new activities and ateliers.



Observational Dataset



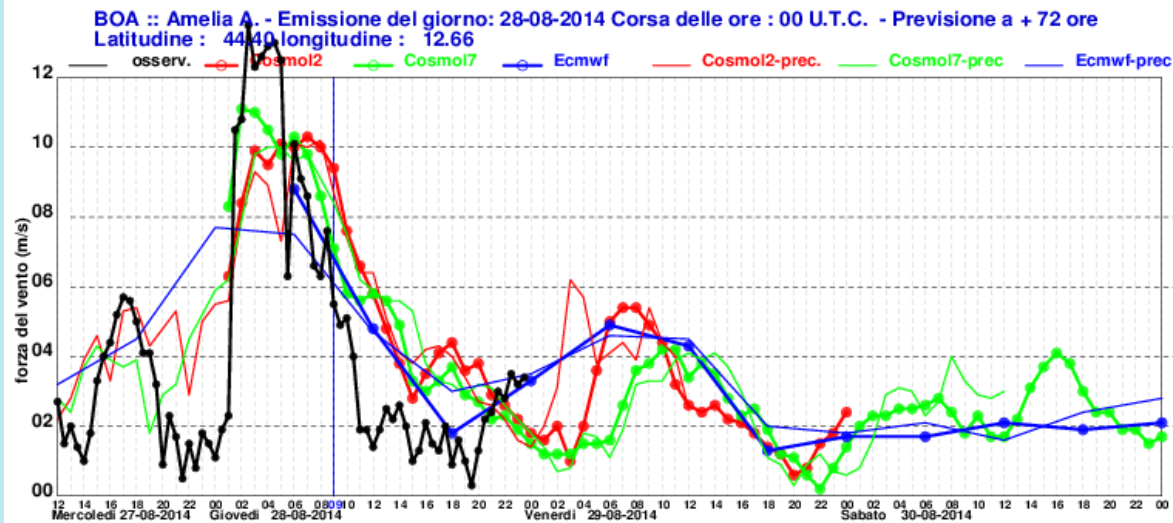
A	44.40,12.66	amelia
B	44.39,12.34	angelina
C	44.52,12.51	anita
D	44.08,13.78	barbara
E	44.47,12.27	piomboni
F	45.31,12.35	arsenale
G	45.23,12.30	chioggia
H	45.38,12.30	malamocco
I	45.31,12.50	torre cnr



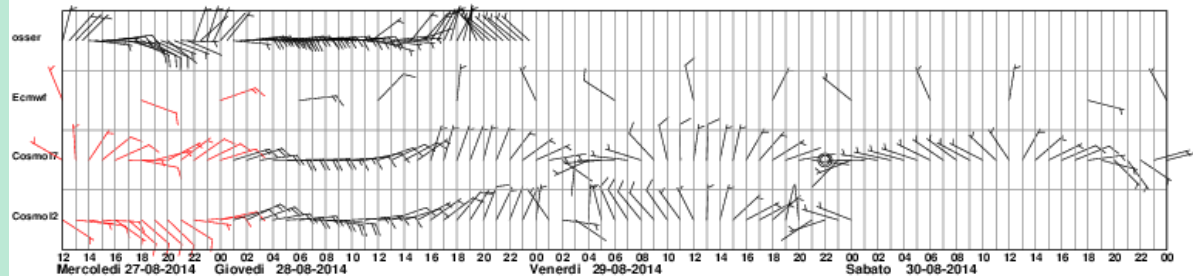
- HOURLY WIND SPEED AND DIRECTION
- PERIOD: 1 JANUARY 2014 – 31 MAY 2014

Example of product for MOSE meteorological support

Wind speed



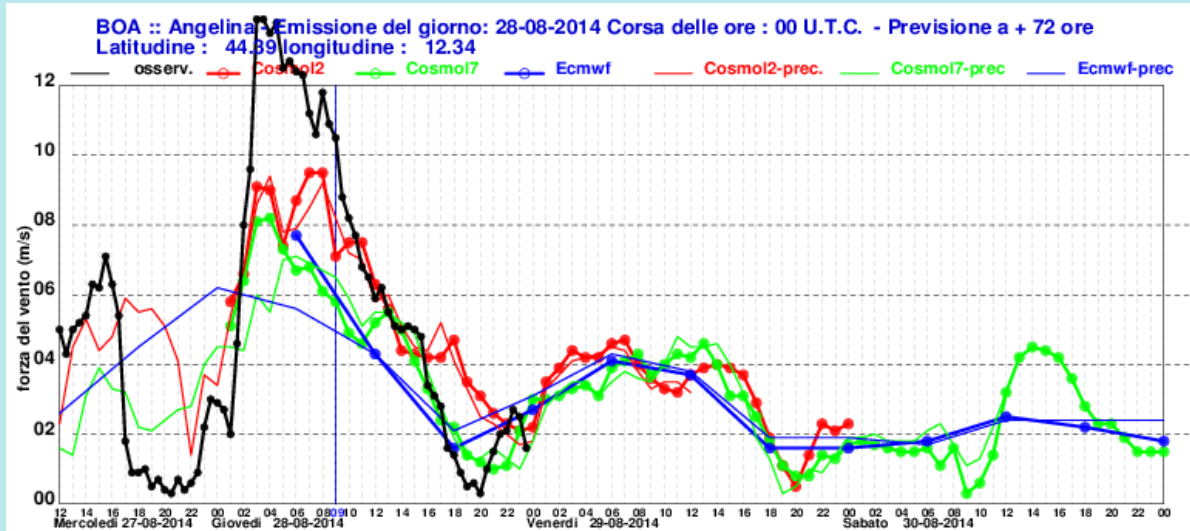
Wind barbs



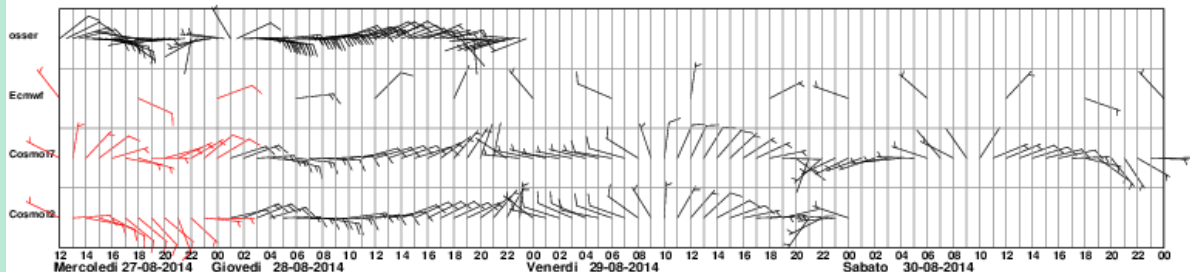
Each hour the observation is updated for a near-real time comparison

Example of product for MOSE meteorological support

Wind speed



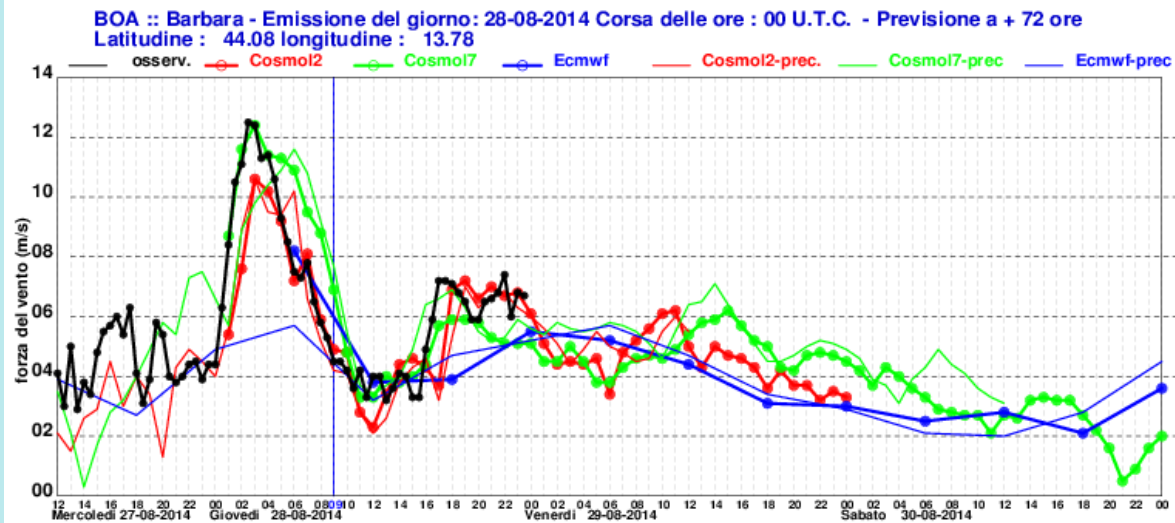
Wind barbs



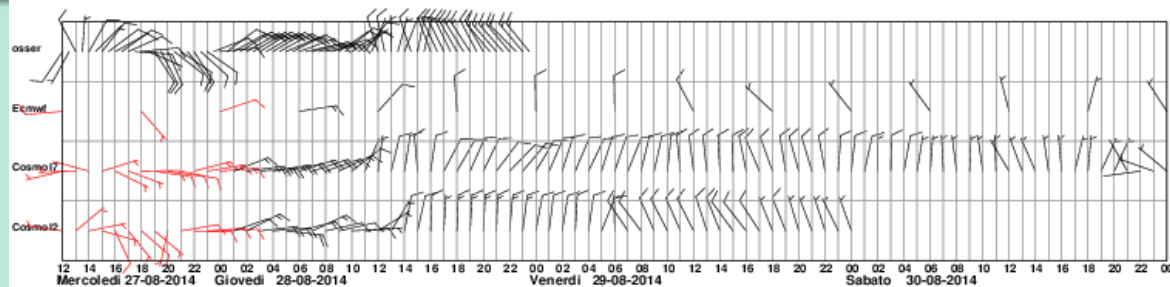
Each hour the observation is updated for a near-real time comparison

Example of product for MOSE meteorological support

Wind speed



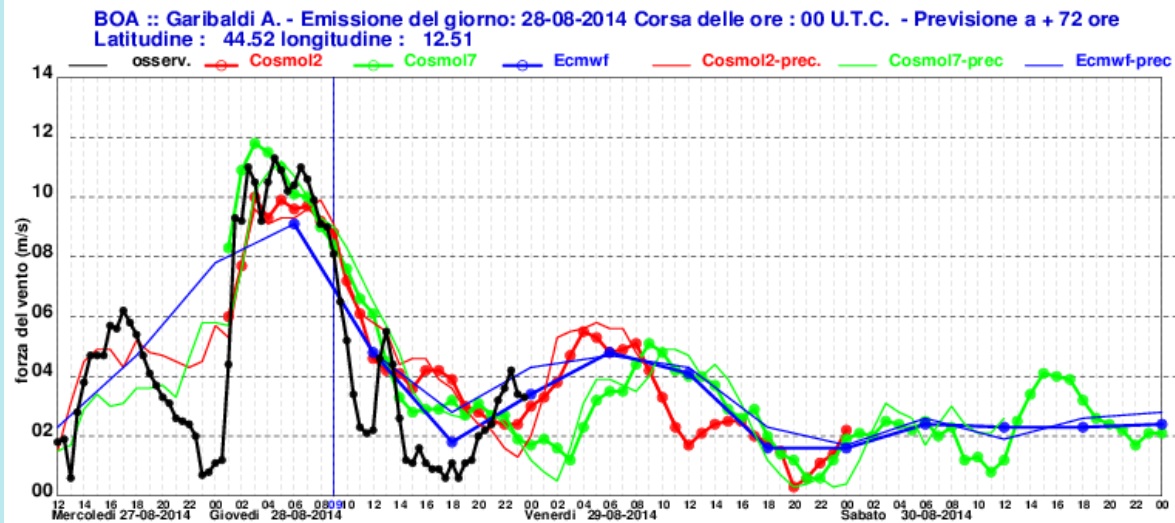
Wind barbs



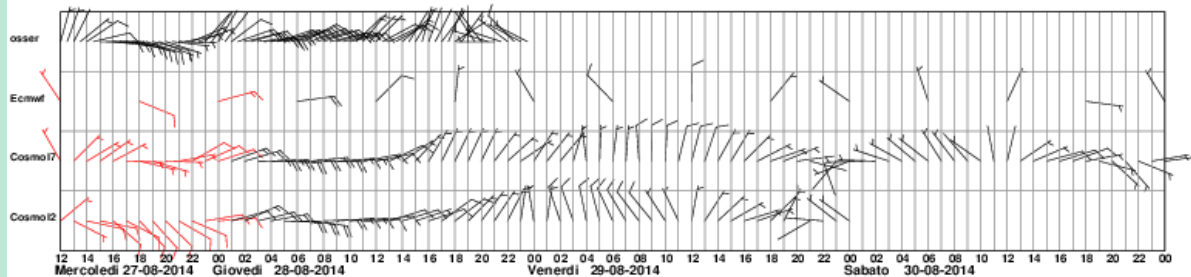
Each hour the observation is updated for a near-real time comparison

Example of product for MOSE meteorological support

Wind speed



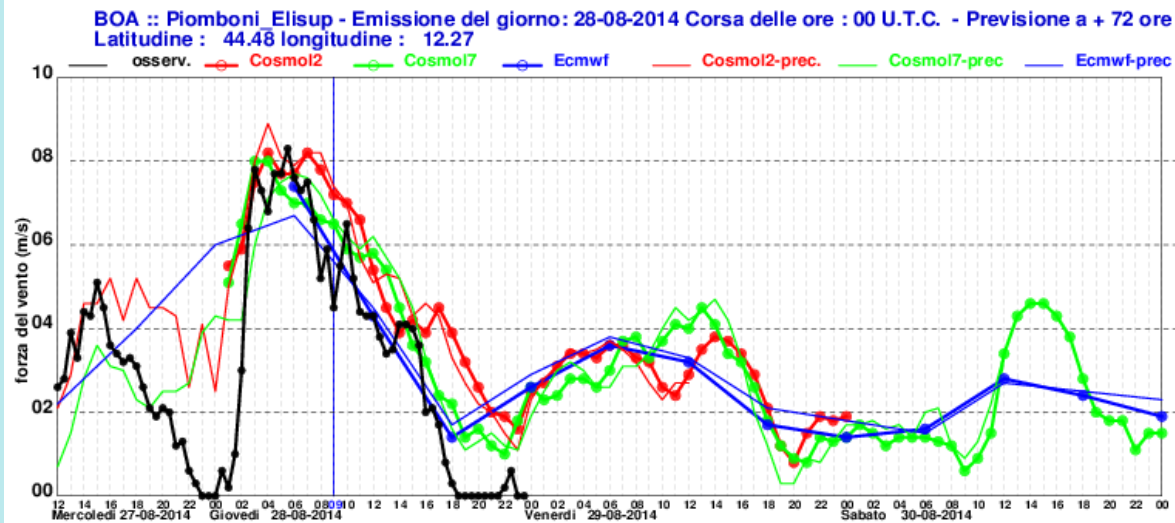
Wind barbs



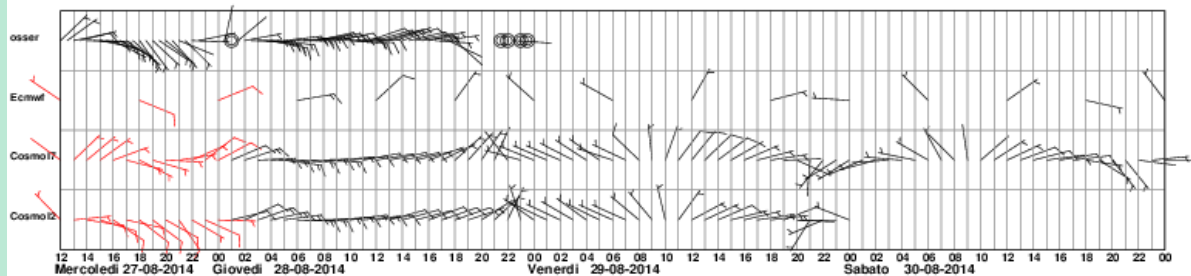
Each hour the observation is updated for a near-real time comparison

Example of product for MOSE meteorological support

Wind speed



Wind barbs



Each hour the observation is updated for a near-real time comparison

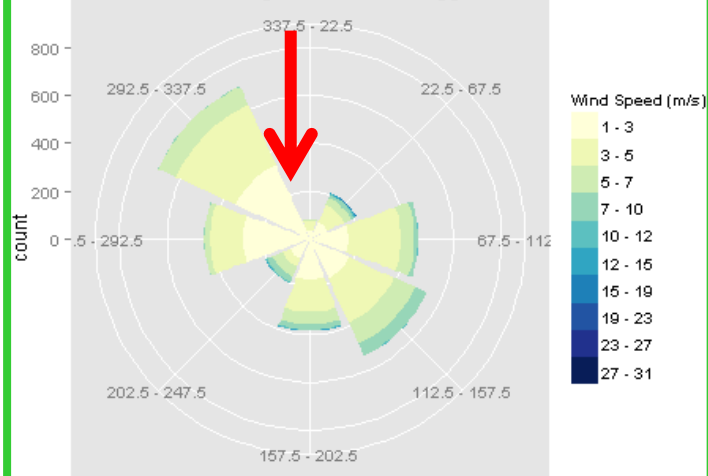
How to verify this type of product on a periodical basis?

- For wind direction, wind roses are plotted for each location
- For wind speed, ME, MAE and RMSE are evaluated for each location
- The most useful thing to do should be investigate the ability of the model to reproduce wind changes:
 - But since wind variations can be related both to large scale forcing and local behavior such as breeze, a sort of climatological study has been performed in order to have an idea of the ability of models to depict diurnally and topographically forced circulations
 - For the moment wind changes have not been taken into account, but are my favorite topics for future works!

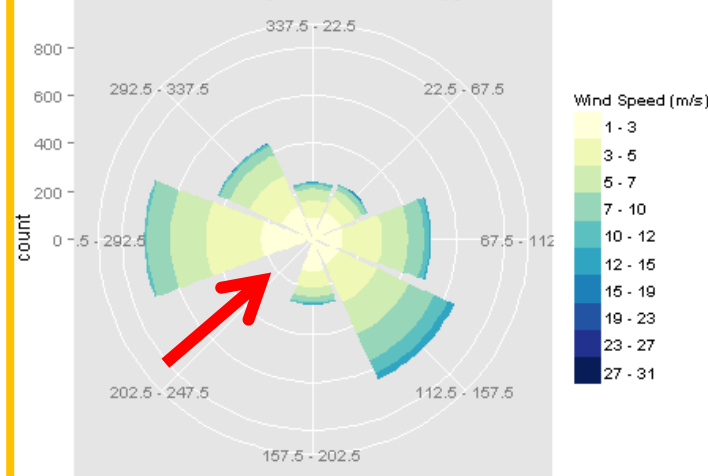
Wind Direction verification: Rose wind for “offshore platforms”



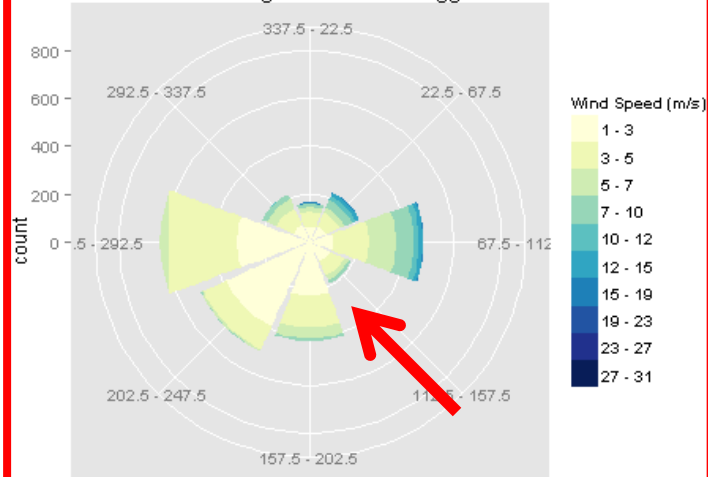
Piomboni (44.48,12.27)
OSSERVAZIONE gennaio-2014 maggio-2014



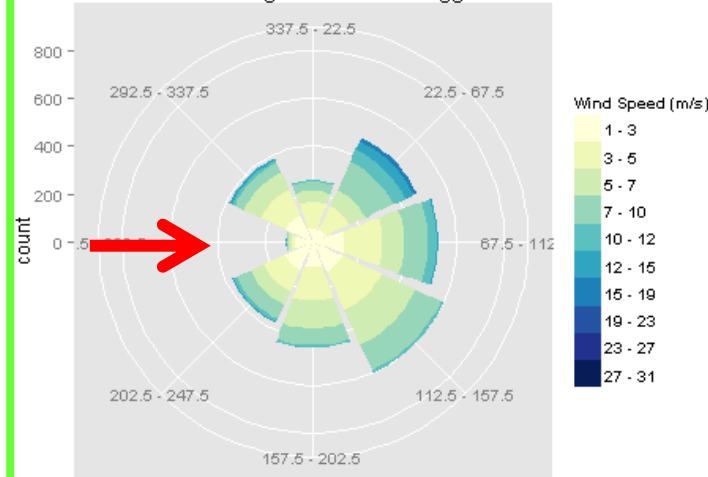
Anita (44.52,12.51)
OSSERVAZIONE gennaio-2014 maggio-2014



Angelina (44.39,12.34)
OSSERVAZIONE gennaio-2014 maggio-2014



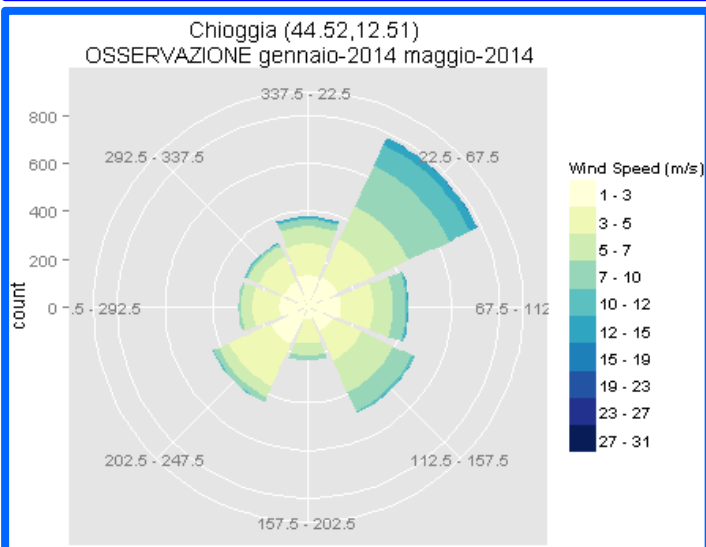
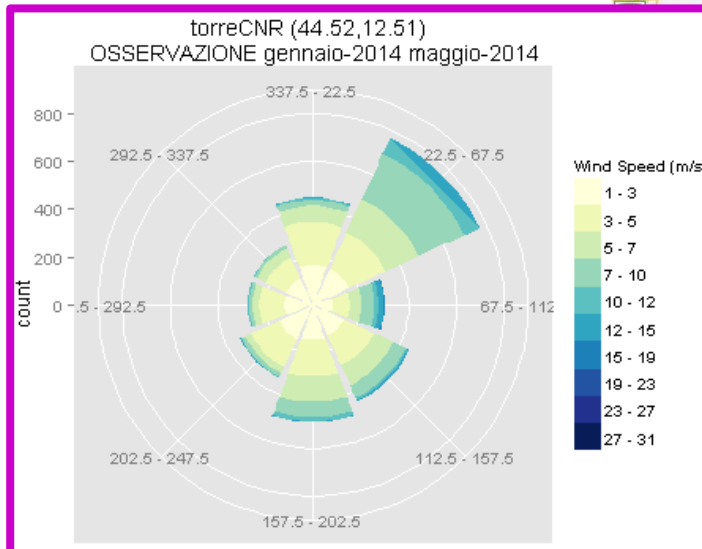
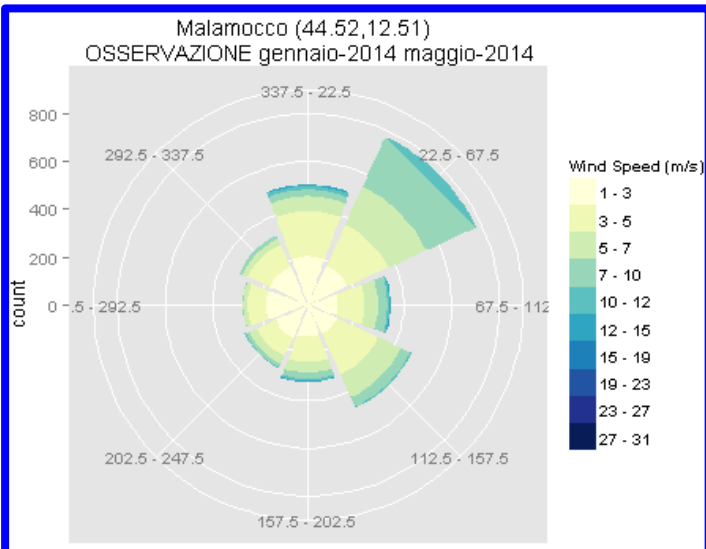
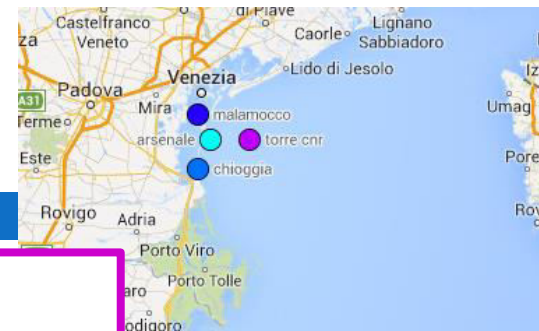
Barbara (44.08,13.78)
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- Some directions seem to be artificially blocked
- Anemometers height are not known, for forecasts we used 10m wind

→ care in results interpretation

Wind Direction verification: Rose wind for MOSE stations



Anemometer height

Malamocco → 15 m

Chioggia → 8 m

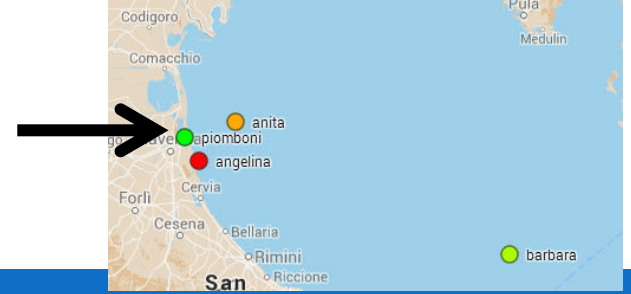
Torre CNR → 8 m

For forecasts
we used 10 m
wind

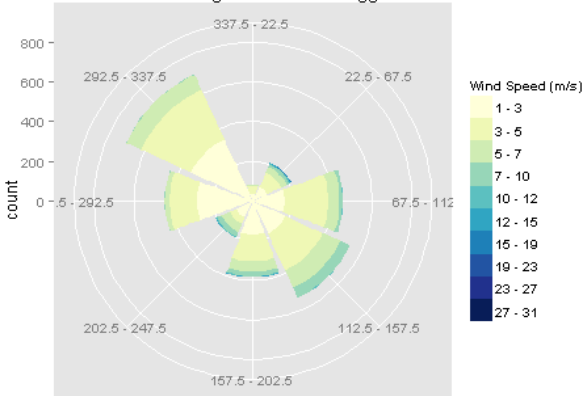
Data are provided by "Venezia Nuova" consortium

“Piomboni”

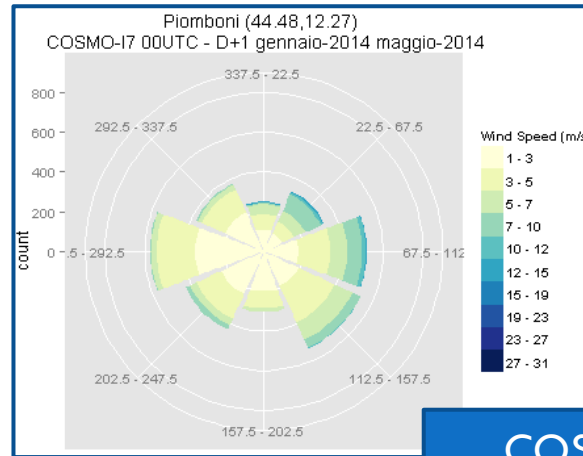
On the coast



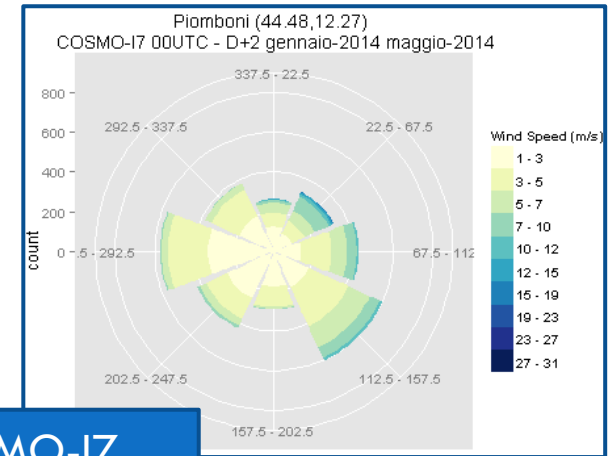
Piomboni (44.48,12.27)
OSSERVAZIONE gennaio-2014 maggio-2014



day 1

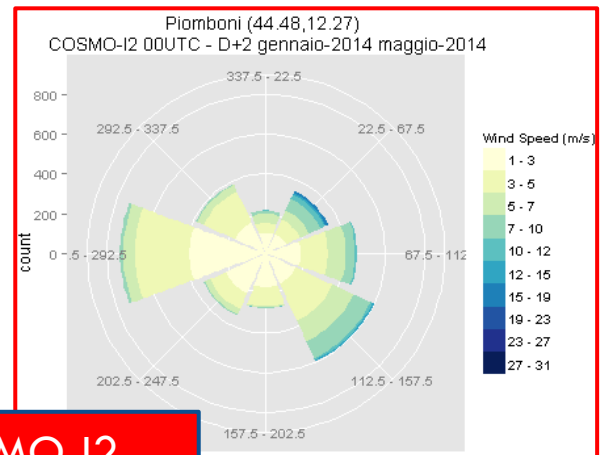
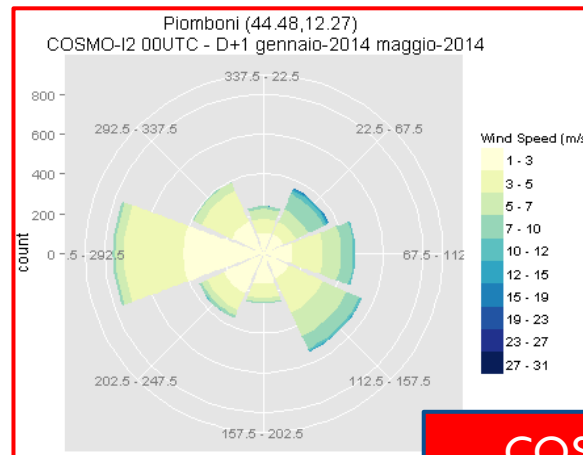


day 2



COSMO-I7

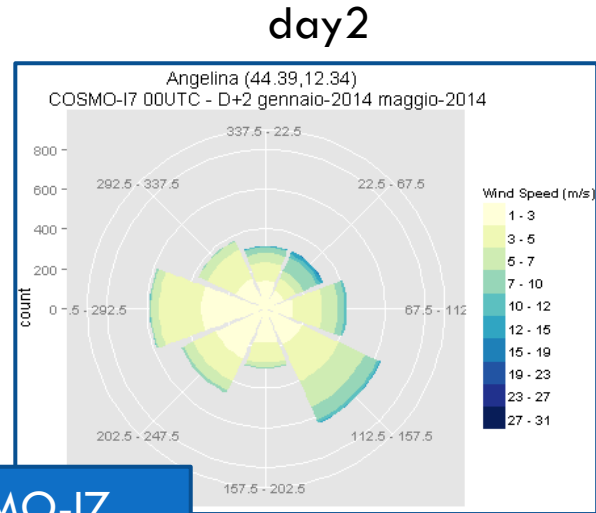
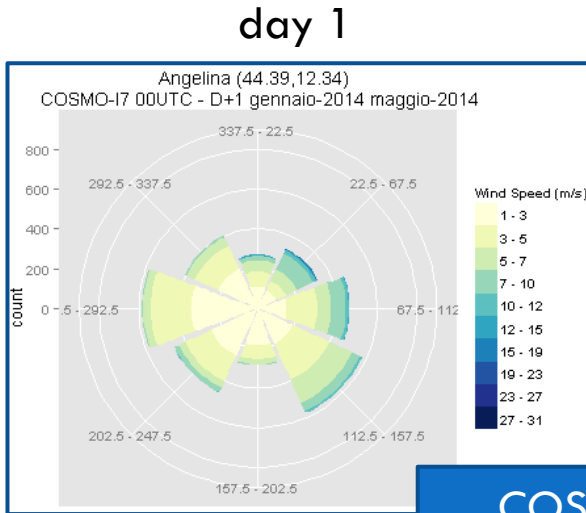
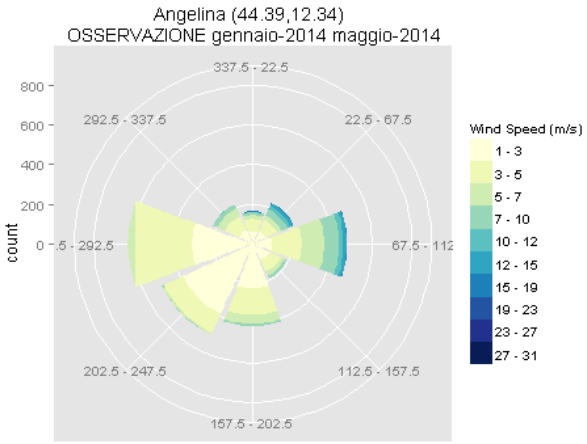
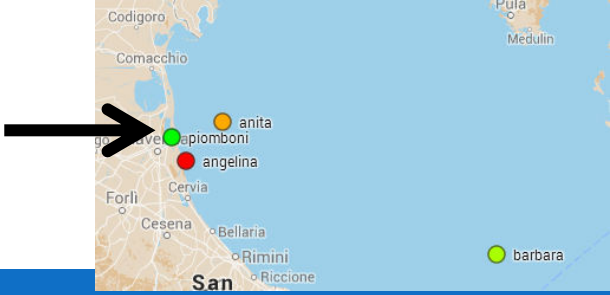
- Models prefer W respect to NW
- Overestimation of E and NE both as intensity and frequency (obs problem?)
- SE well described
- COSMO-I2 differs from I7 in W frequency



COSMO-I2

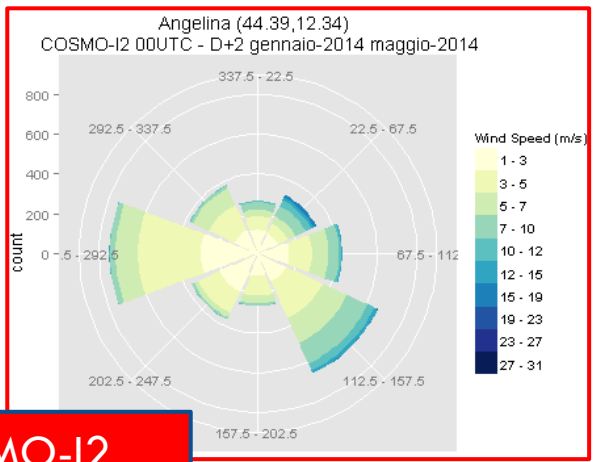
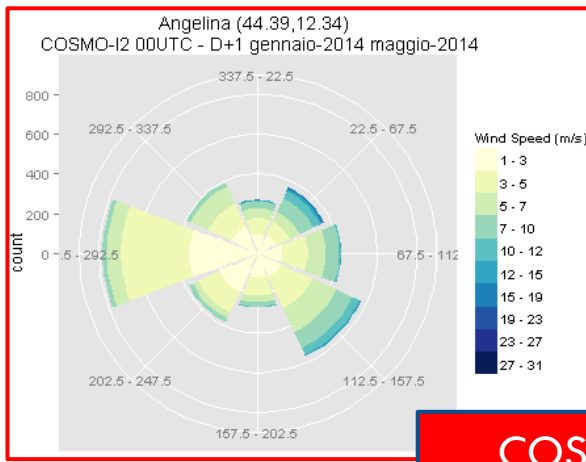
“Angelina”

Near to the coast



COSMO-I7

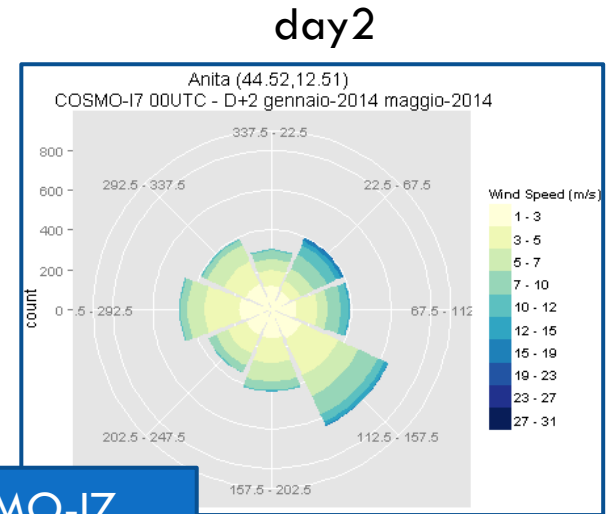
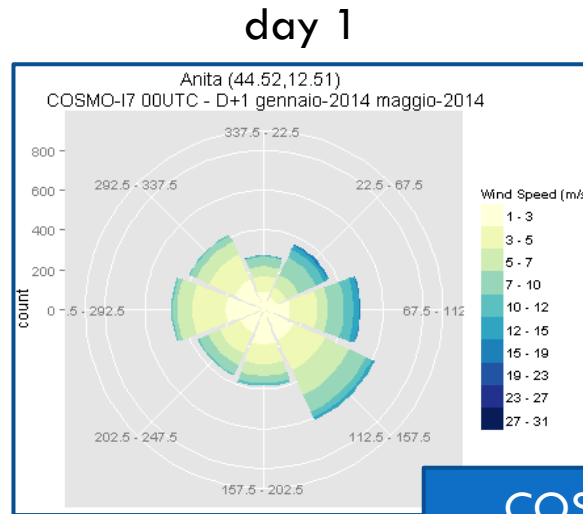
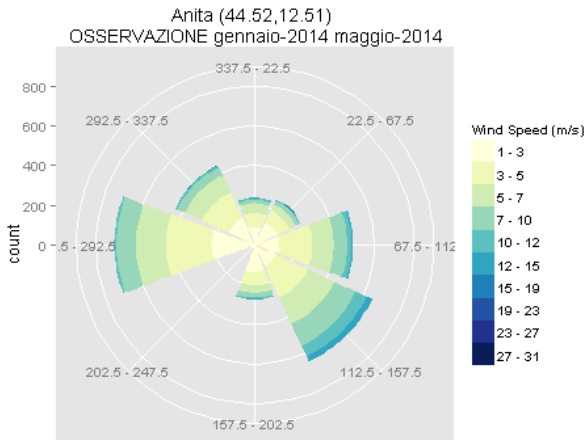
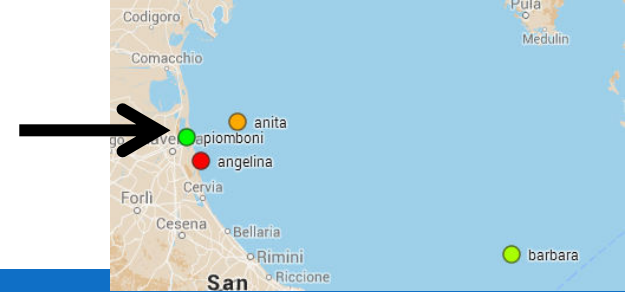
- SE obs problem!
- N & NE overestimation
- E well described as frequency but speed lightly underestimated
- C-I2 > C-I7 for W



COSMO-I2

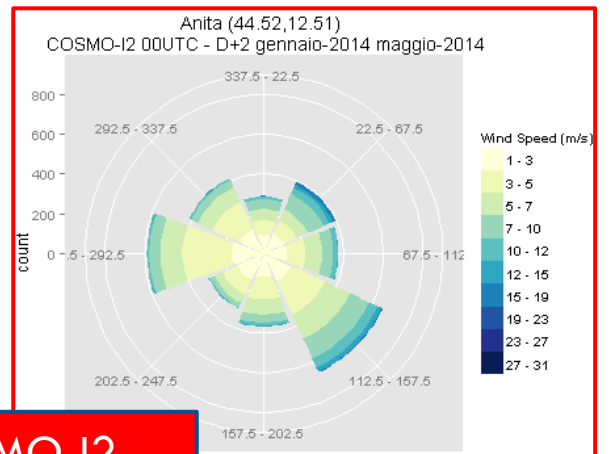
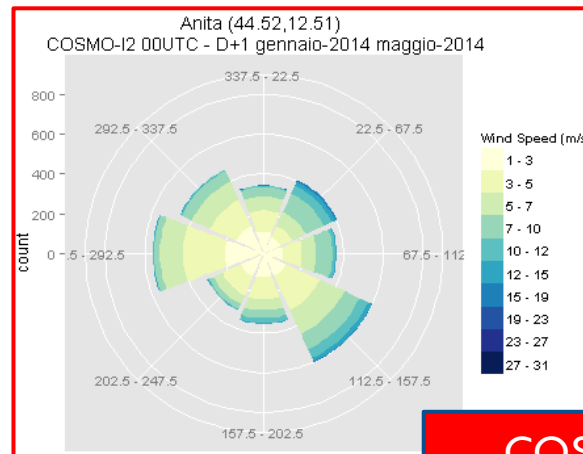
“Anita”

Off-shore 25 Km from the coast



COSMO-I7

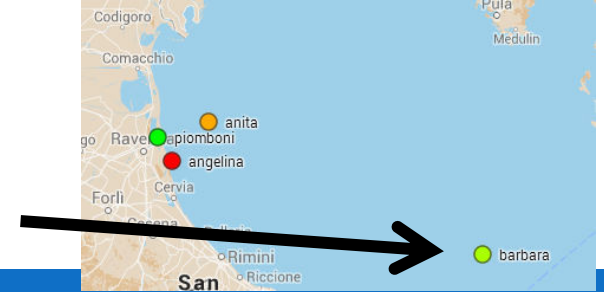
- W is underestimated, CI2 slightly better than CI7
- Good in SE
- NE & S overestimated



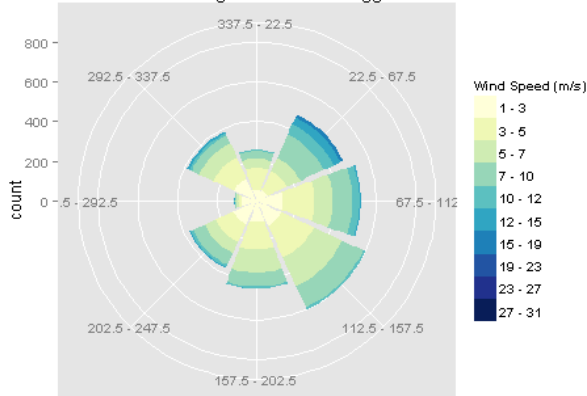
COSMO-I2

“Barbara”

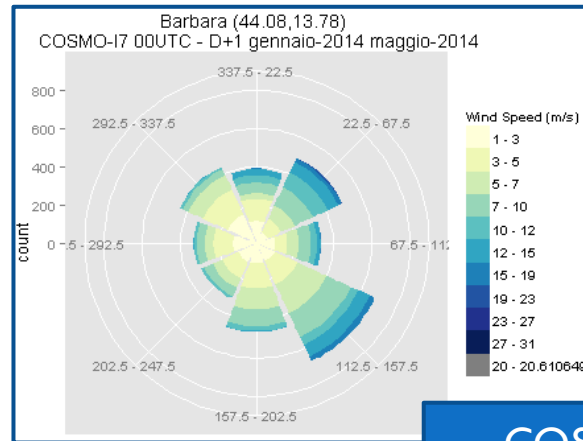
Off shore 150 Km from the coast



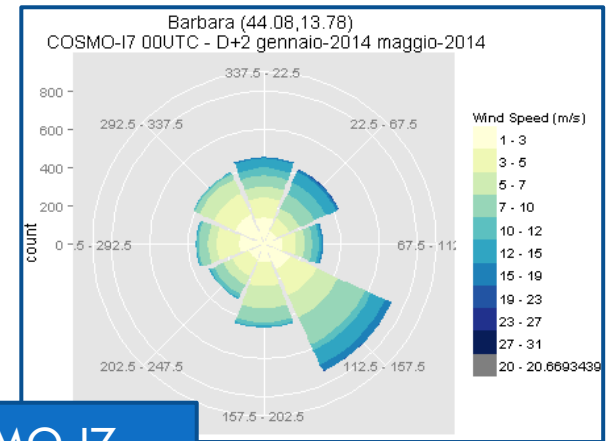
Barbara (44.08,13.78)
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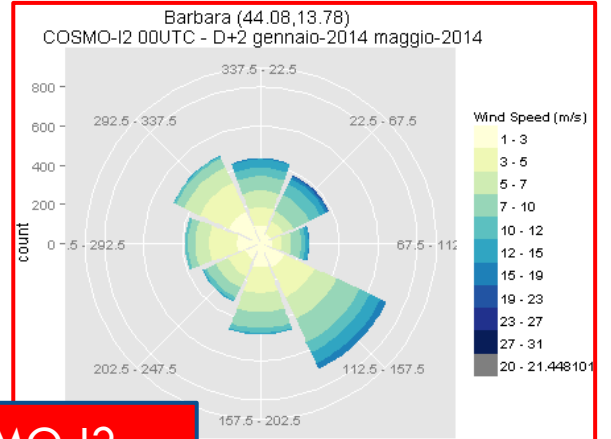
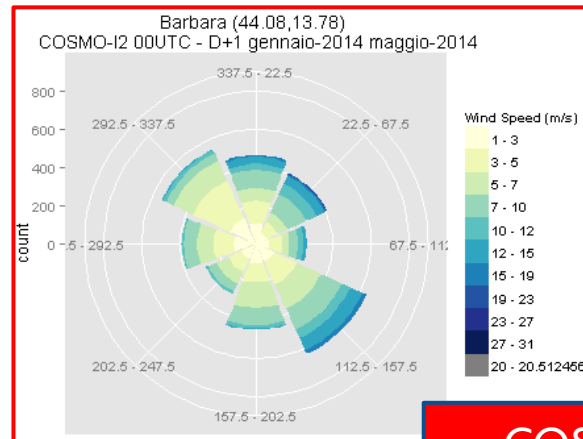
day 1



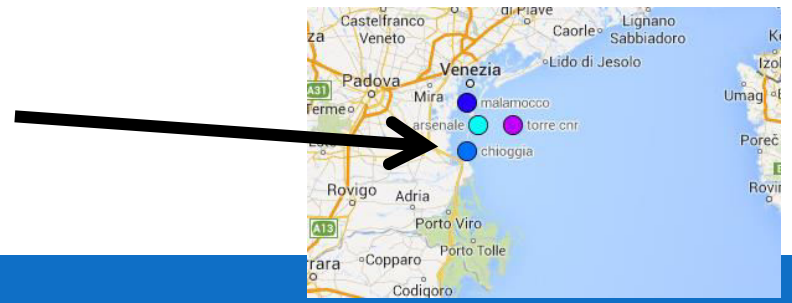
day2



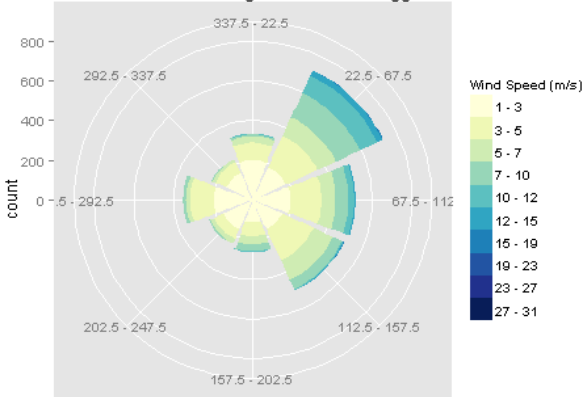
- NE well reproduced
- models prefer SE to E
- Wind speed overestimated



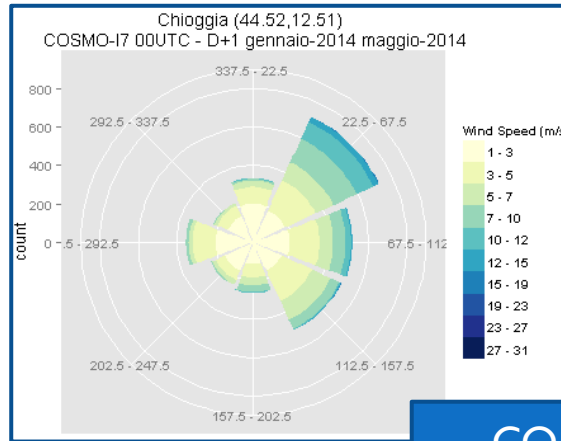
“Chioggia”



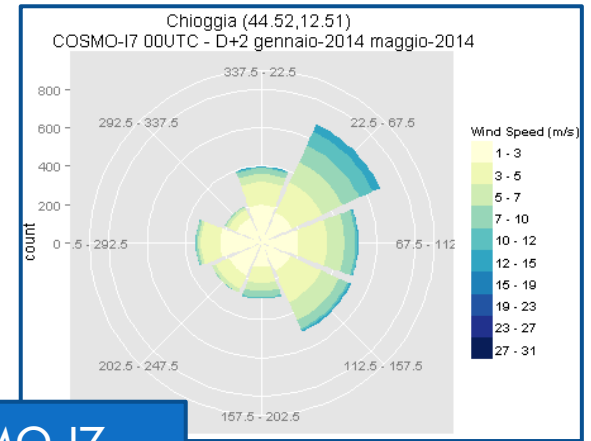
Chioggia (44.52,12.51)
COSMO-I7 00UTC - D+1 gennaio-2014 maggio-2014



day 1

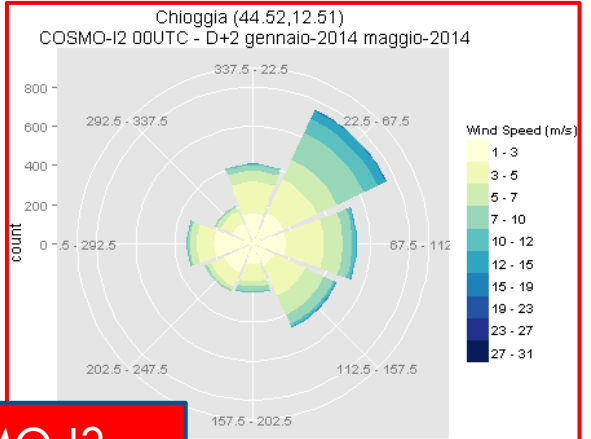
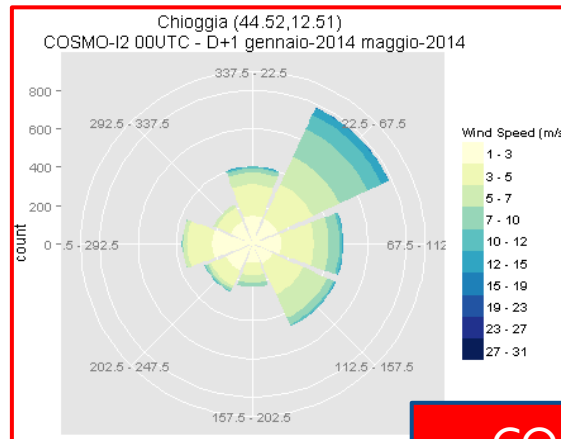


day 2



COSMO-I7

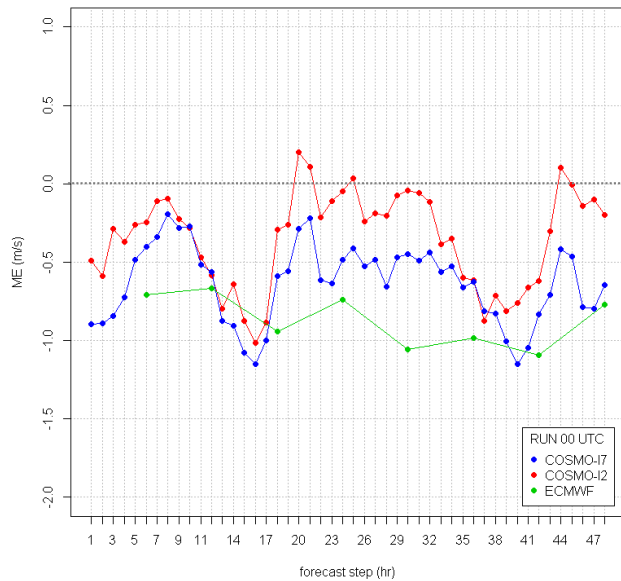
- very good representation of wind field



COSMO-I2

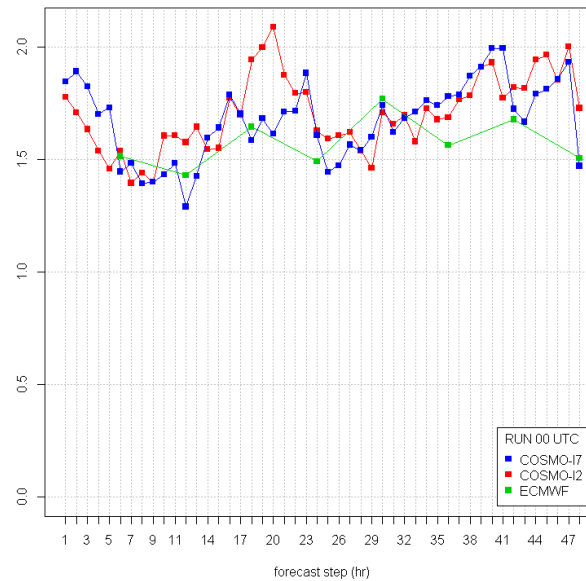
Chioggia: wind speed errors

Mean Error Wind Speed - Chioggia (44.52,12.51)
gennaio-2014 - maggio-2014



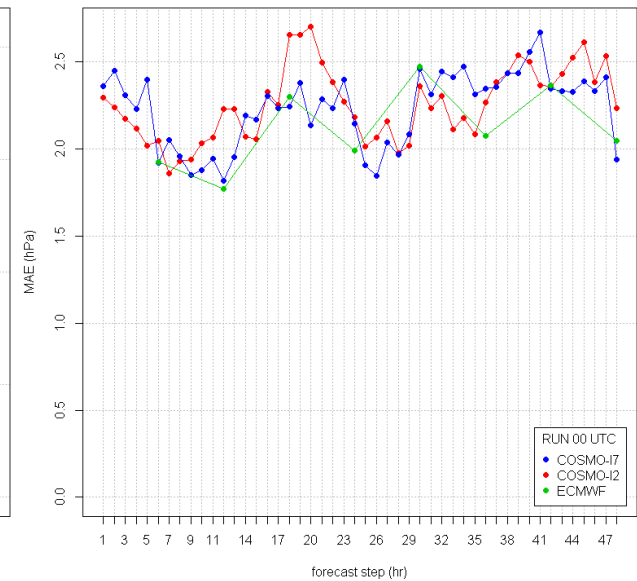
ME

Mean Absolute Error Wind Speed - Chioggia (44.52,12.51)
gennaio-2014 - maggio-2014



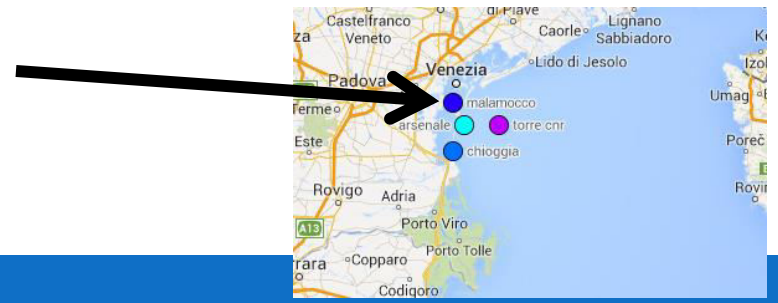
MAE

Root Mean Square Error Wind Speed - Chioggia (44.52,12.51)
gennaio-2014 - maggio-2014

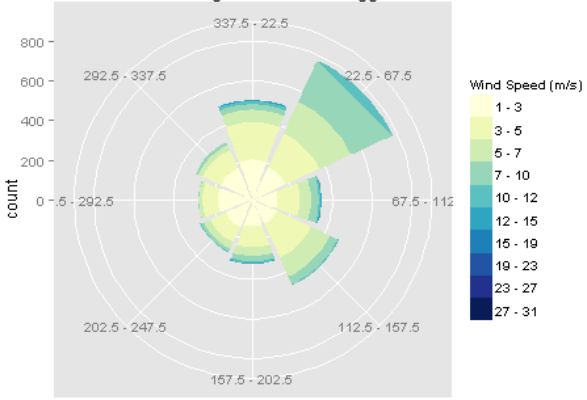


RMSE

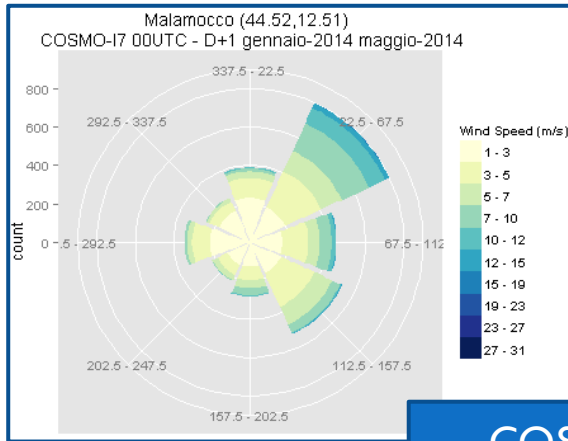
“Malamocco”



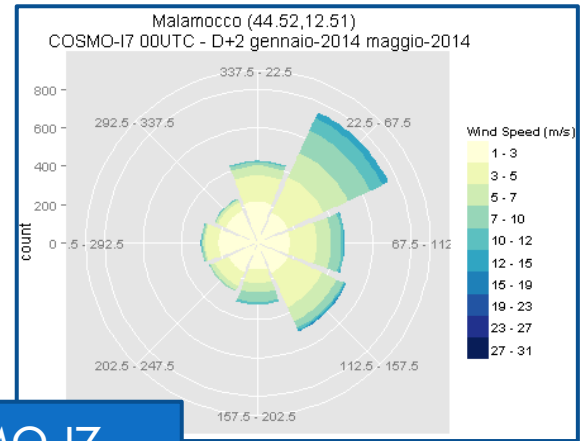
Malamocco (44.52,12.51)
OSSERVAZIONE gennaio-2014 maggio-2014



day 1

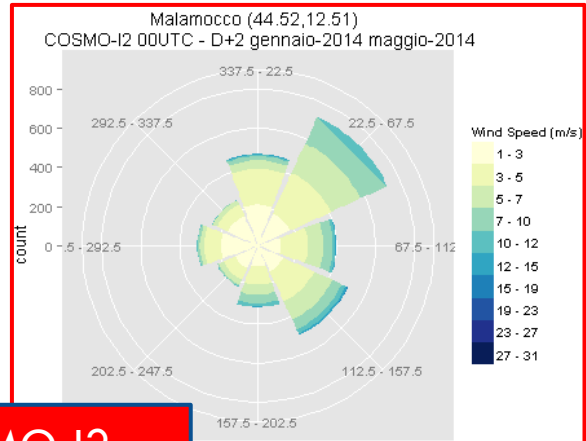
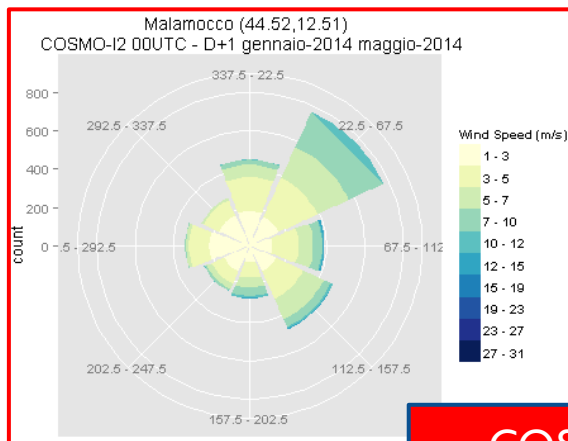


day 2



COSMO-I7

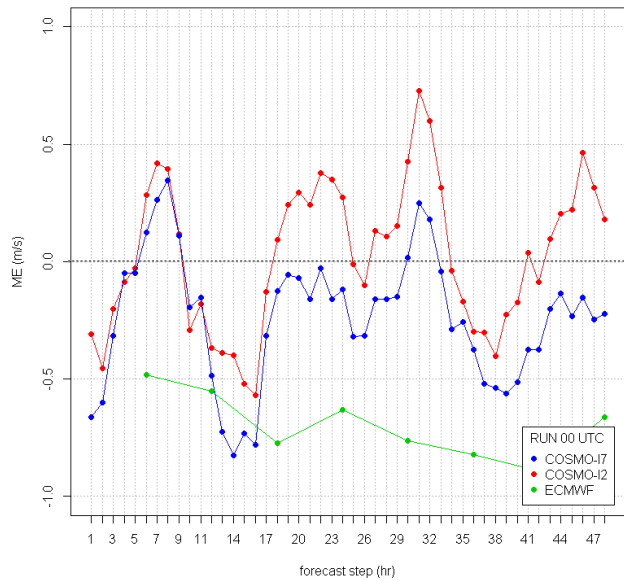
- very good representation of wind direction frequency
- CI7 tends to overestimate wind speed in particular from NE



COSMO-I2

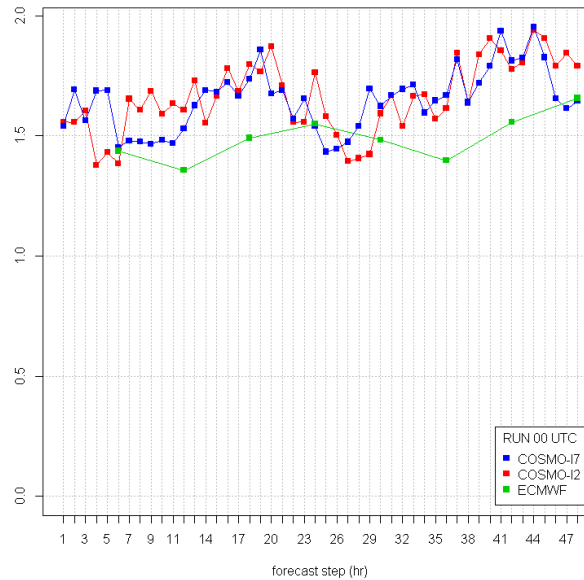
Malamocco: wind speed errors

Mean Error Wind Speed - Malamocco (44.52,12.51)
gennaio-2014 - maggio-2014



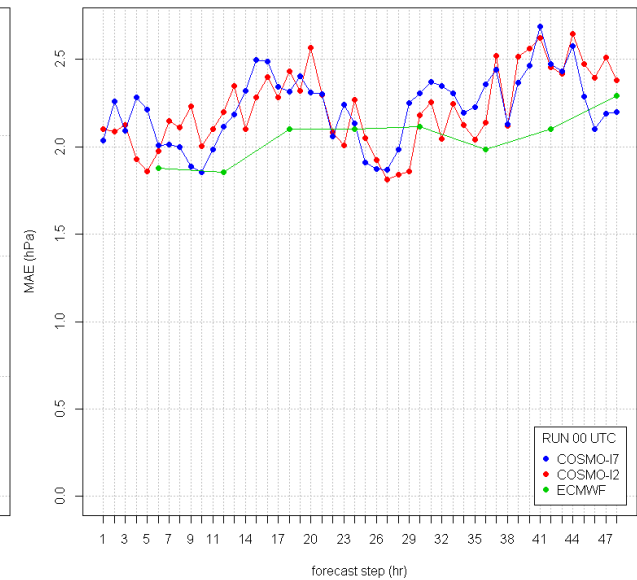
ME

Mean Absolute Error Wind Speed - Malamocco (44.52,12.51)
gennaio-2014 - maggio-2014



MAE

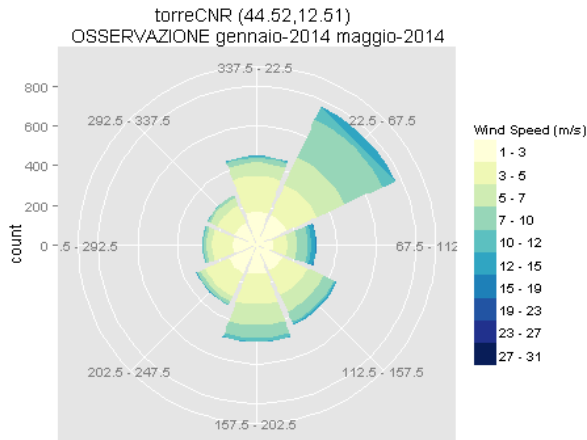
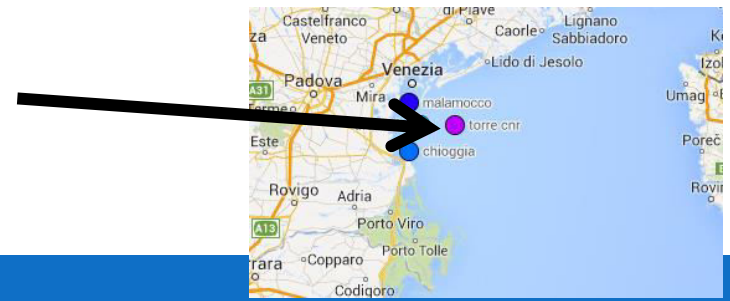
Root Mean Square Error Wind Speed - Malamocco (44.52,12.51)
gennaio-2014 - maggio-2014



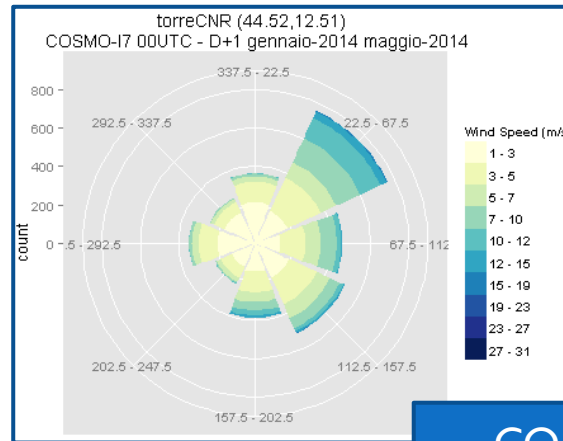
RMSE

On average the overestimation of wind speed of COSMO-I7 does not appear...

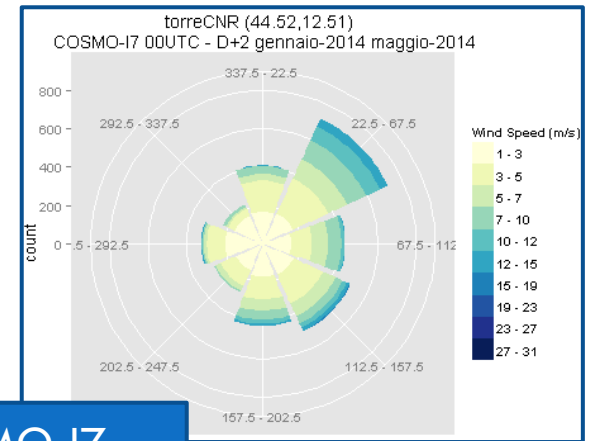
“Torre CNR”



day 1

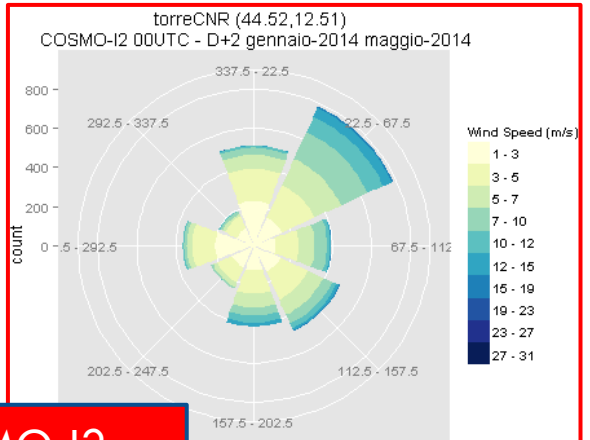
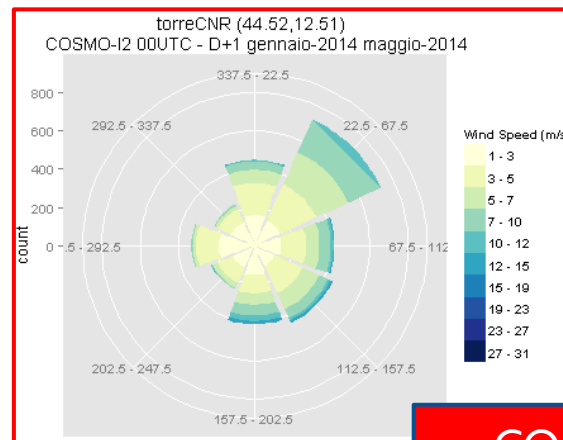


day2



COSMO-I7

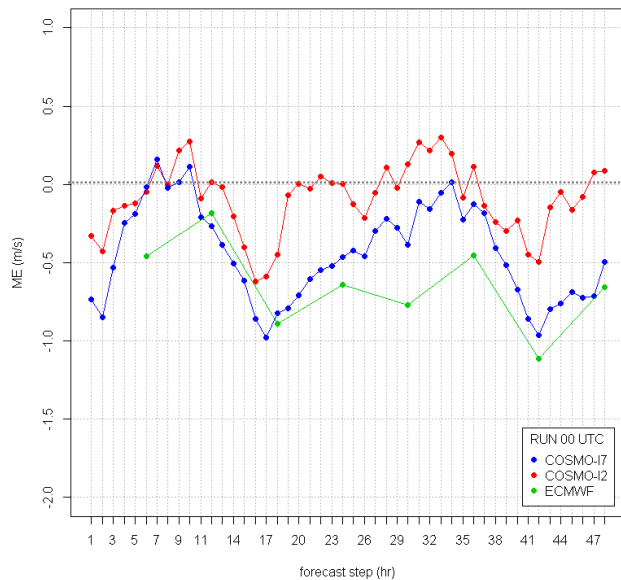
- NE good as total frequency but CI7 tends to overestimate wind speed, CI2 underestimates
- frequency of E overestimated



COSMO-I2

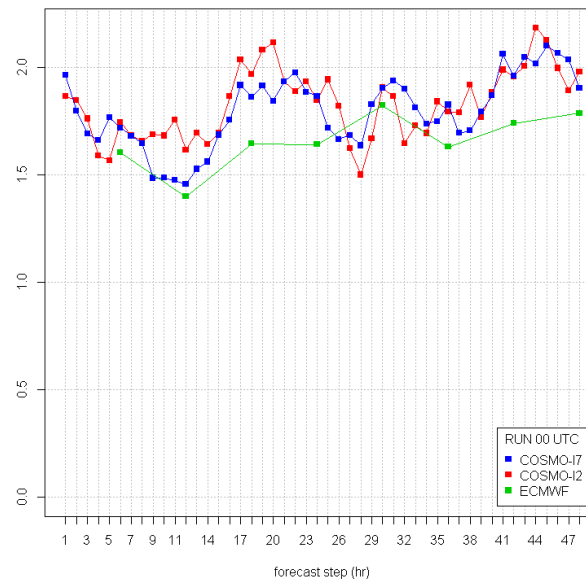
TorreCNR: wind speed errors

Mean Error Wind Speed - torreCNR (44.52,12.51)
gennaio-2014 - maggio-2014



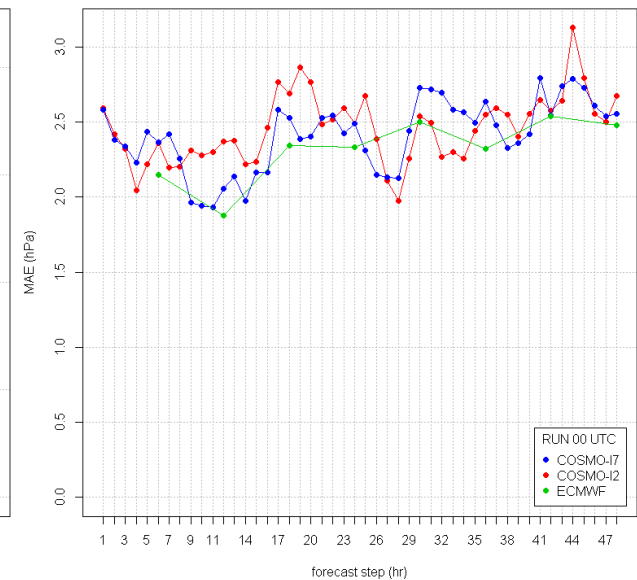
ME

Mean Absolute Error Wind Speed - torreCNR (44.52,12.51)
gennaio-2014 - maggio-2014



MAE

Root Mean Square Error Wind Speed - torreCNR (44.52,12.51)
gennaio-2014 - maggio-2014



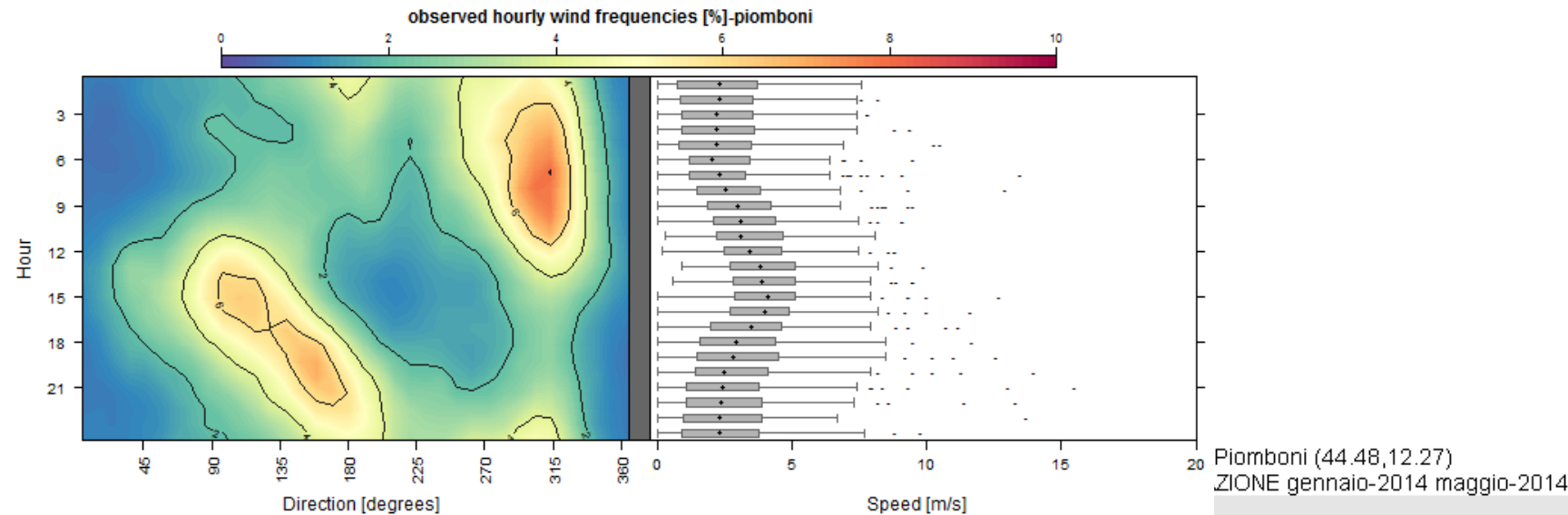
RMSE

Also in this case on average the NE overestimation does not appear, maybe a stratification for direction should be necessary...but the number of plot will grow as the information to give to the end-user...

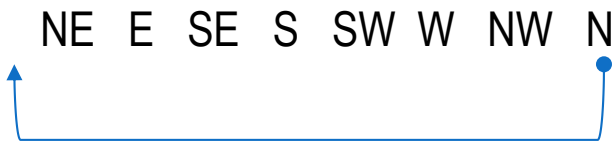
Visualizing diurnal wind climatology

- Getting information on diurnal climate dynamics is especially important in regions of complex terrain or for coastal locations, where diurnally reversing wind flow patterns are a major climatic feature
- R package from “metvurst repository” (<https://github.com/tim-salabim/metvurst>)
 - It is intended to provide a compact overview of the wind field climatology at a location and plots wind direction and speed as a function of the hour of day.
 - direction is plotted as frequencies of occurrences
 - speed is represented by a box plot

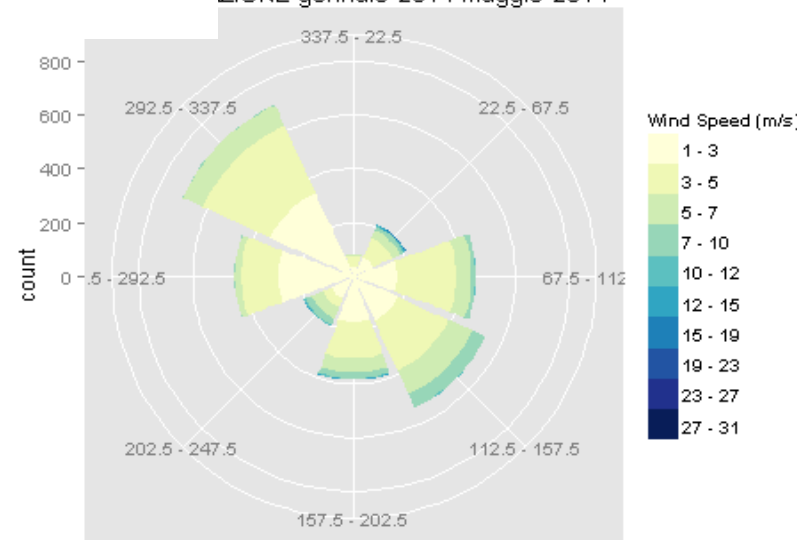
Visualizing diurnal wind climatology



Piomboni (44.48,12.27)
ZIONE gennaio-2014 maggio-2014

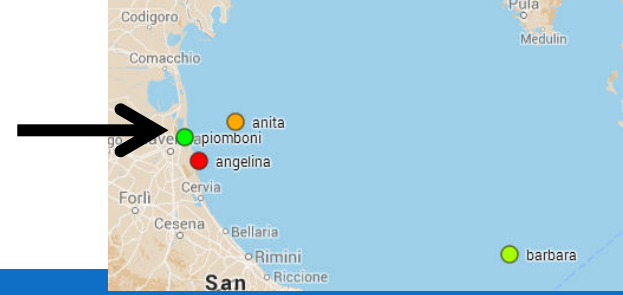


In the next graphs some examples of these plots are presented to illustrate some of the properties that can be deduced from this type of plot. Results are not complete to define the quality of the models

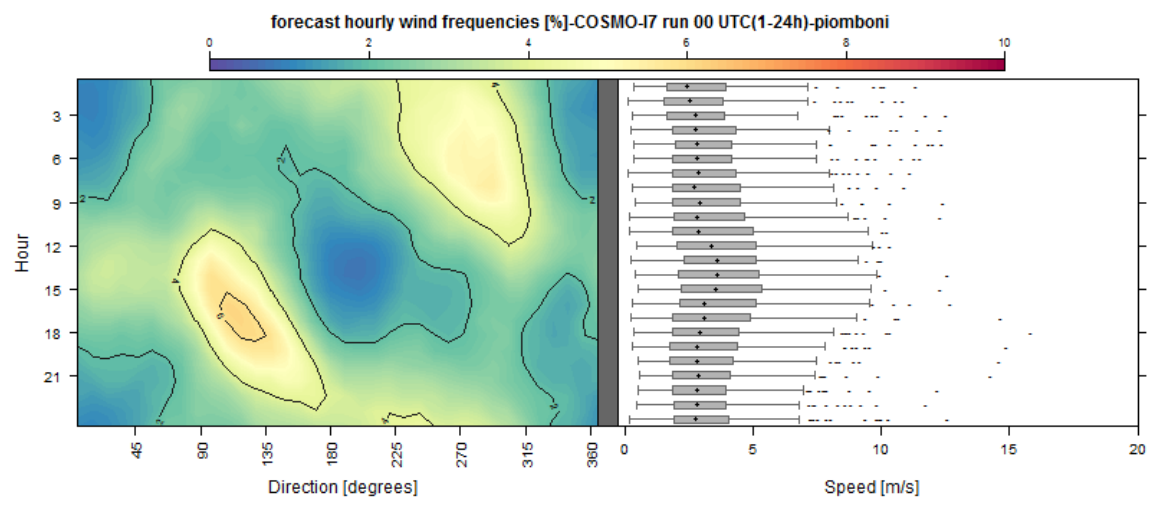
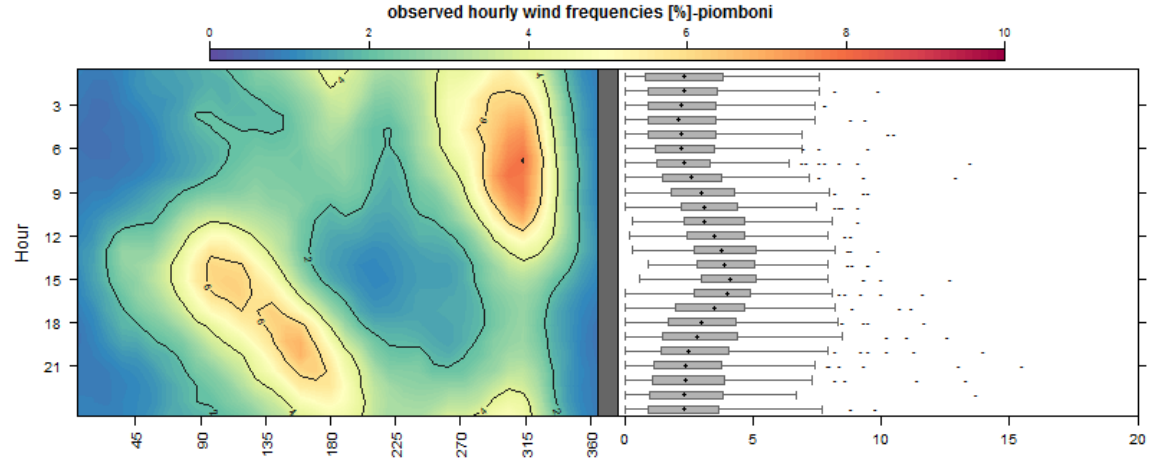


“Piomboni”

On the coast



observation

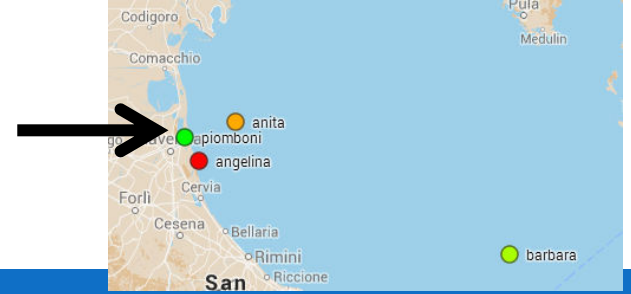


Direction are quite well reproduced, a part from NW that is less frequent in forecast

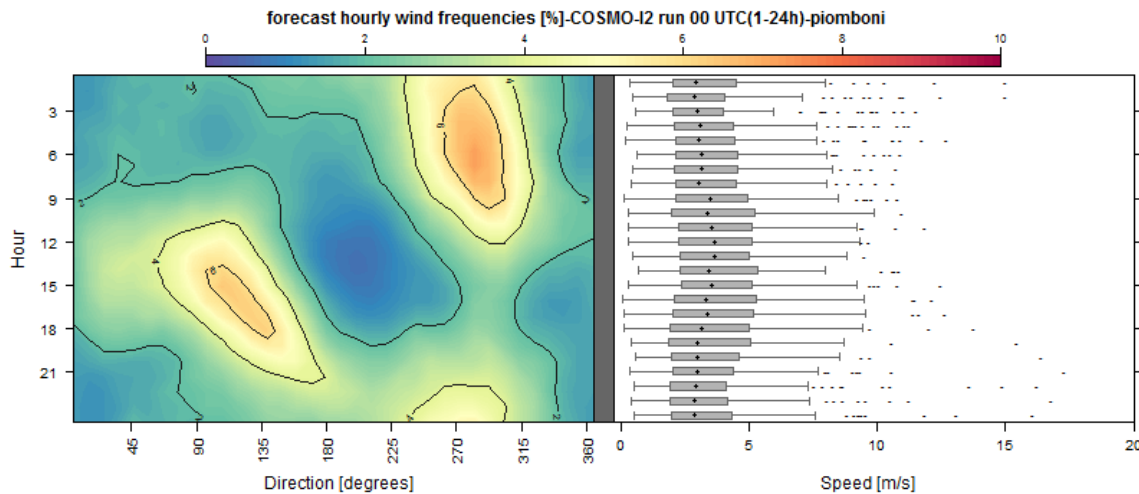
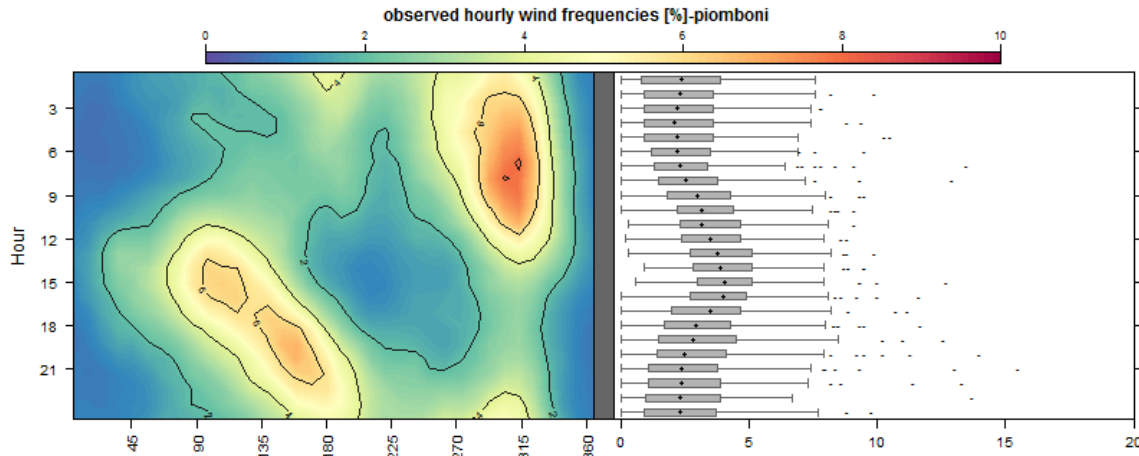
Differences in diurnal cycle of intensity

“Piomboni”

On the coast



observation



Cosmo-I2 describe better the NW direction but with overestimation of intensity

Diurnal cycle in wind speed not very pronounced

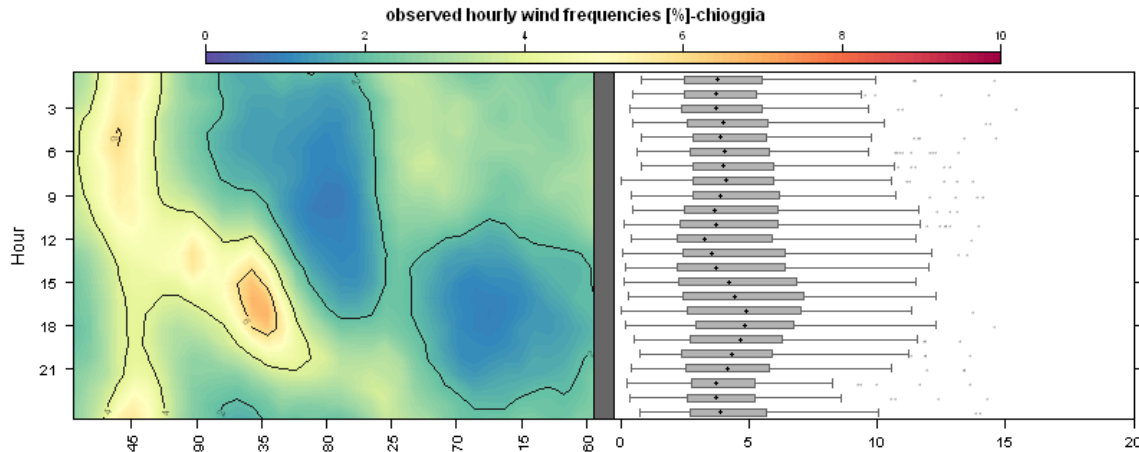
Outliers in the evening hours are comparable

COSMO-I2 day 1

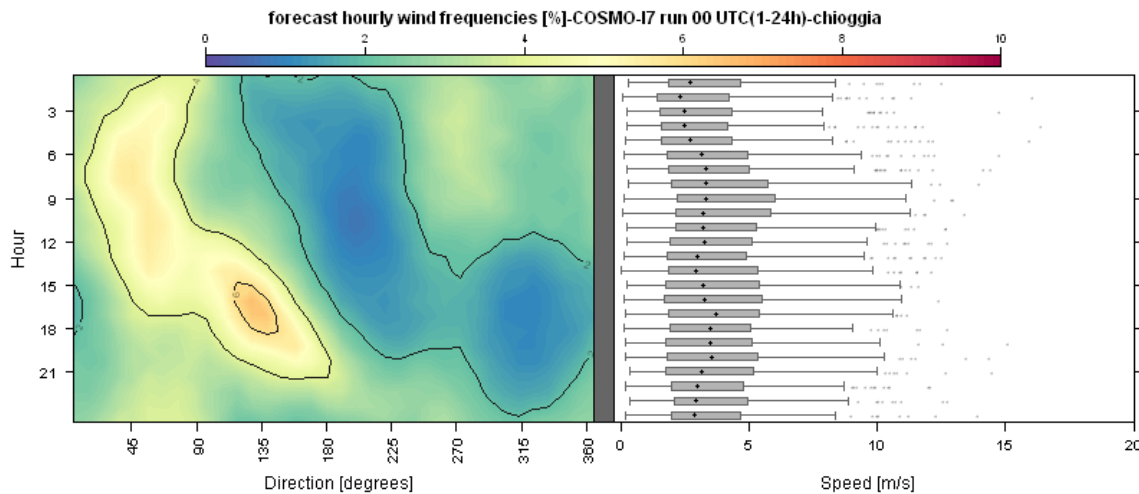
"Chioggia"



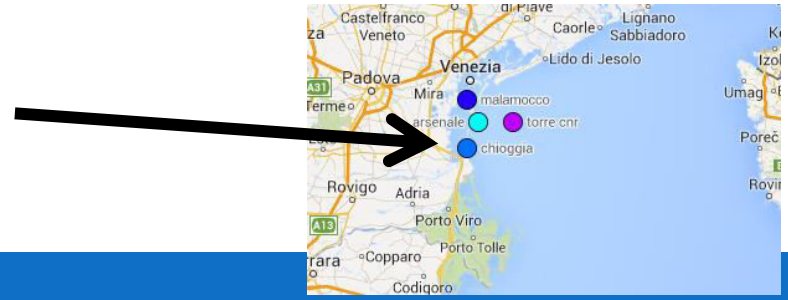
observation



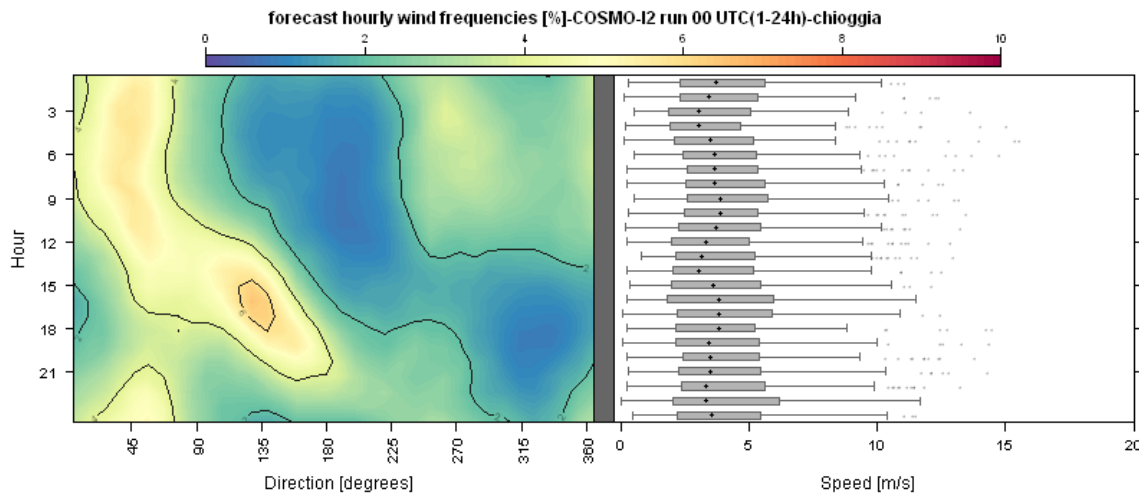
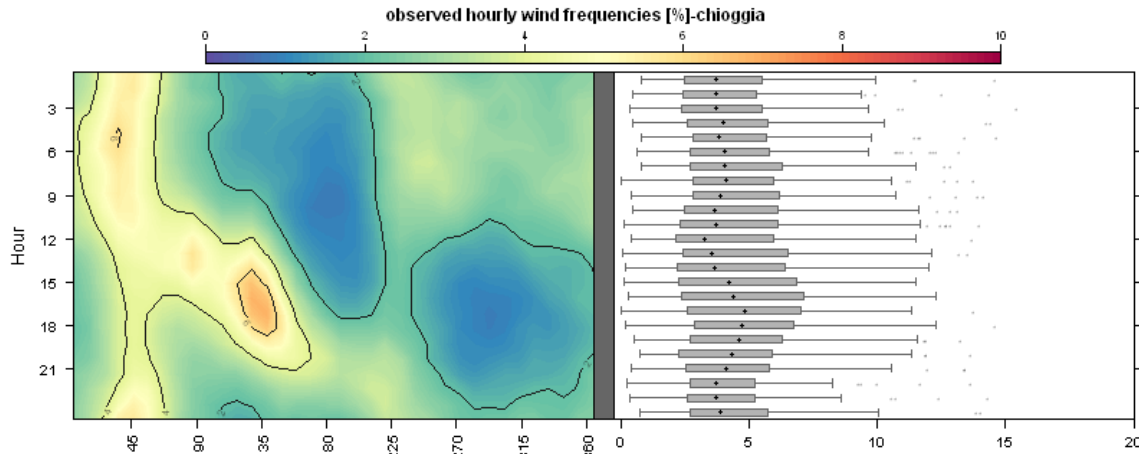
Wind speed is underestimated and diurnal cycle not very evident



"Chioggia"

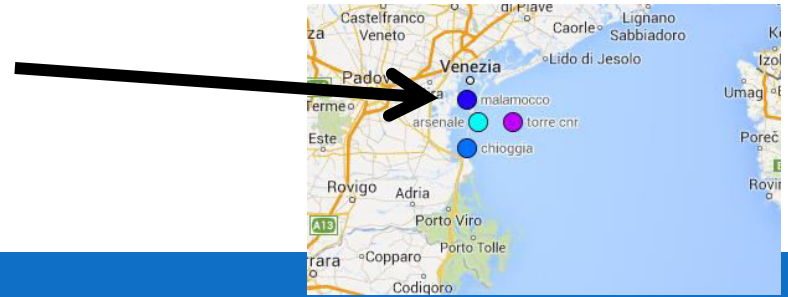


observation

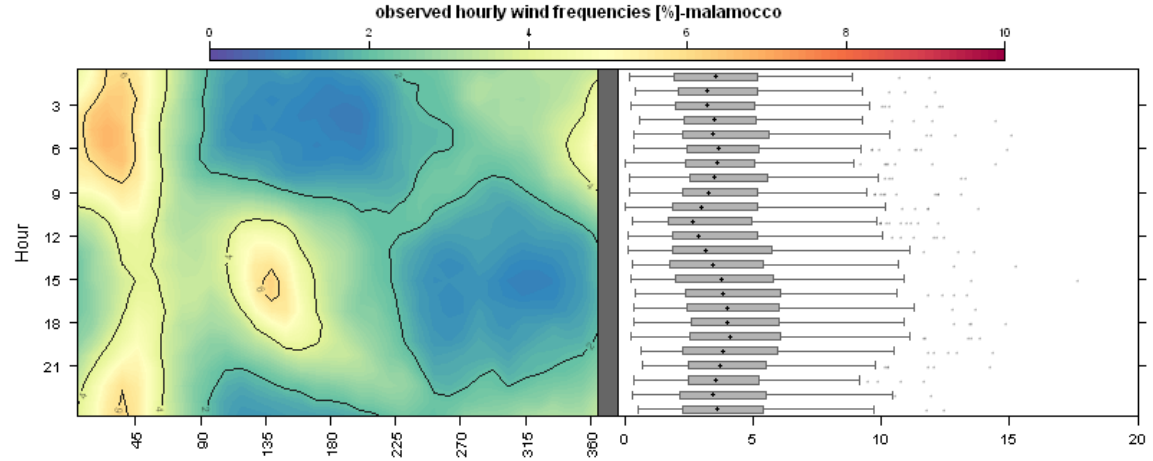


Better representation of direction but diurnal cycle not well reproduce, even if slightly better than CI7

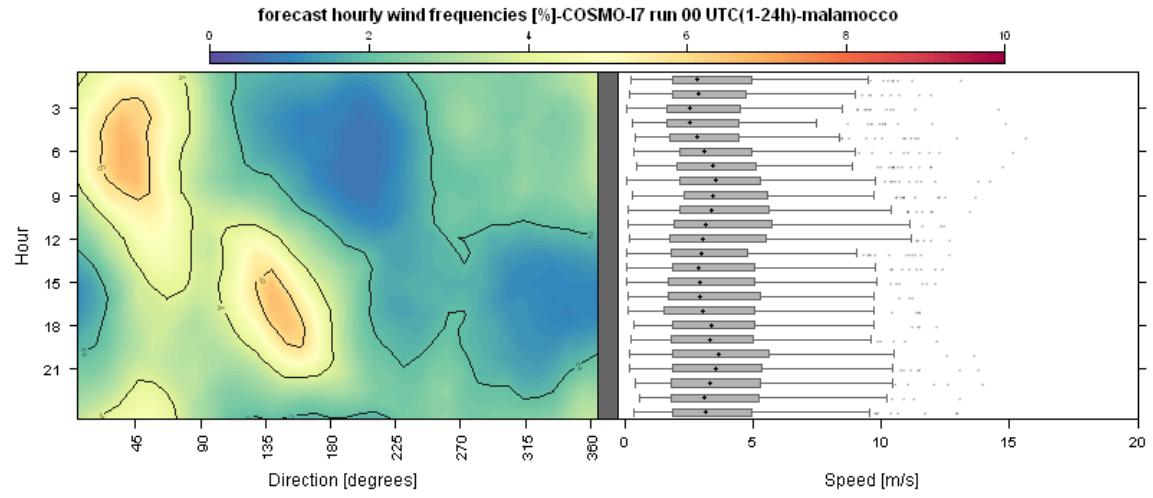
"Malamocco"



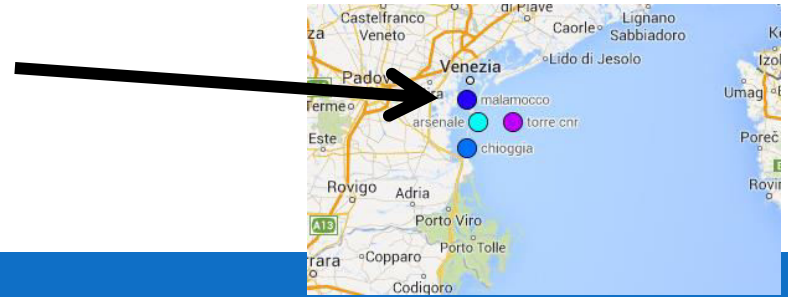
observation



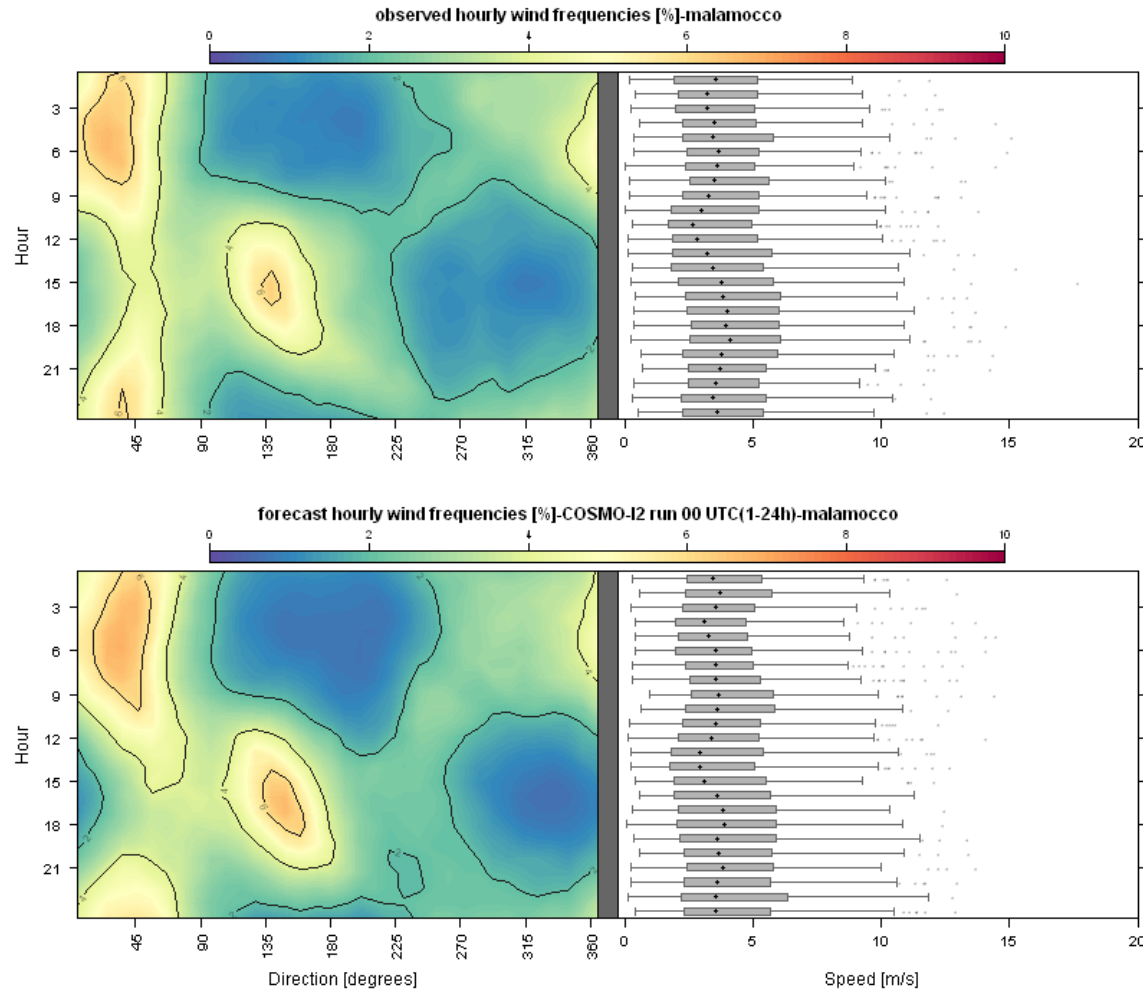
The direction are not so bad, but diurnal cycle is different



"Malamocco"

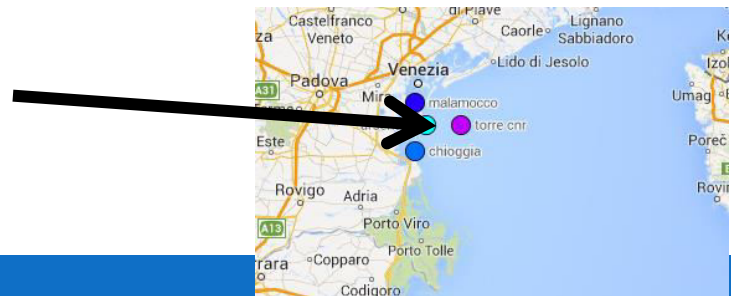


observation

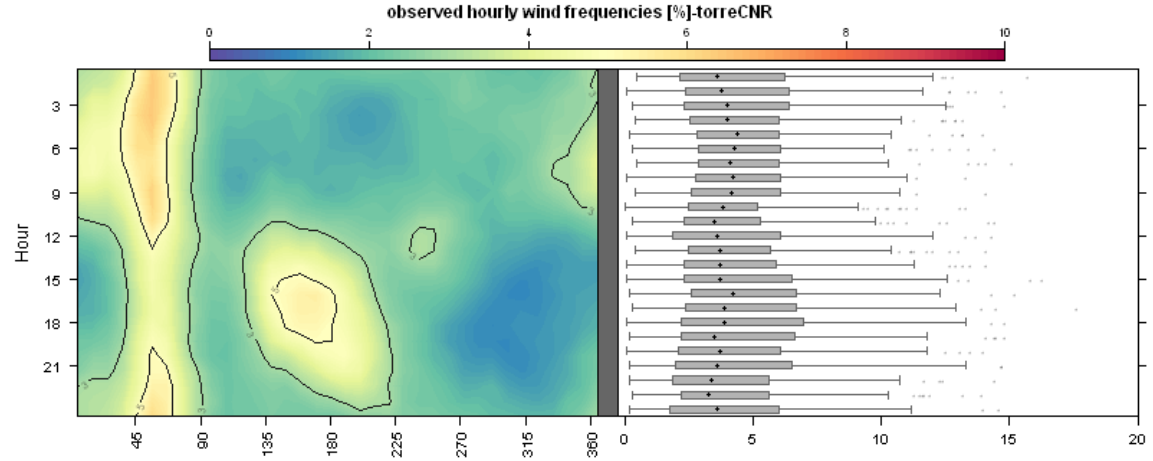


Good for direction,
Even the diurnal cycle
seems a bit better but
the hour of the
minimum is different
(about 12 UTC for
obs, 15 UTC for
model)

"Torre CNR"

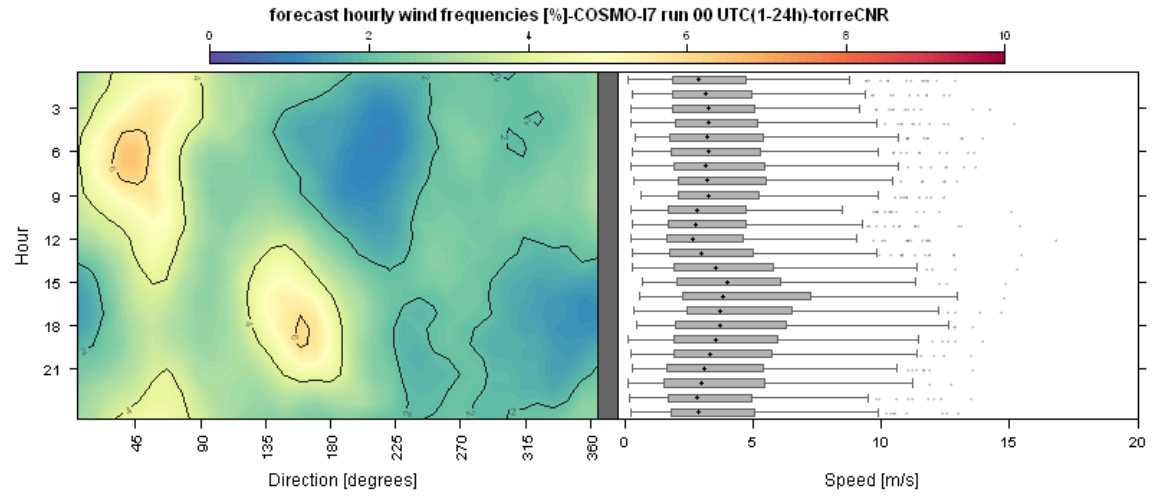


observation

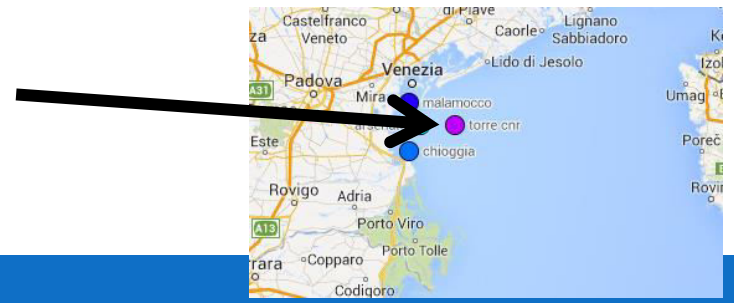


Directions are different

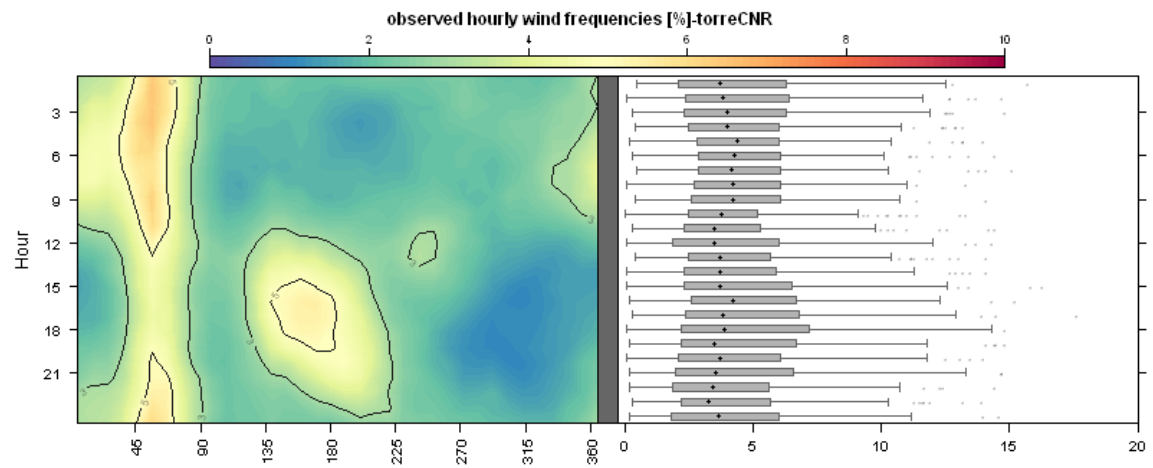
Diurnal cycle seems better than in other locations



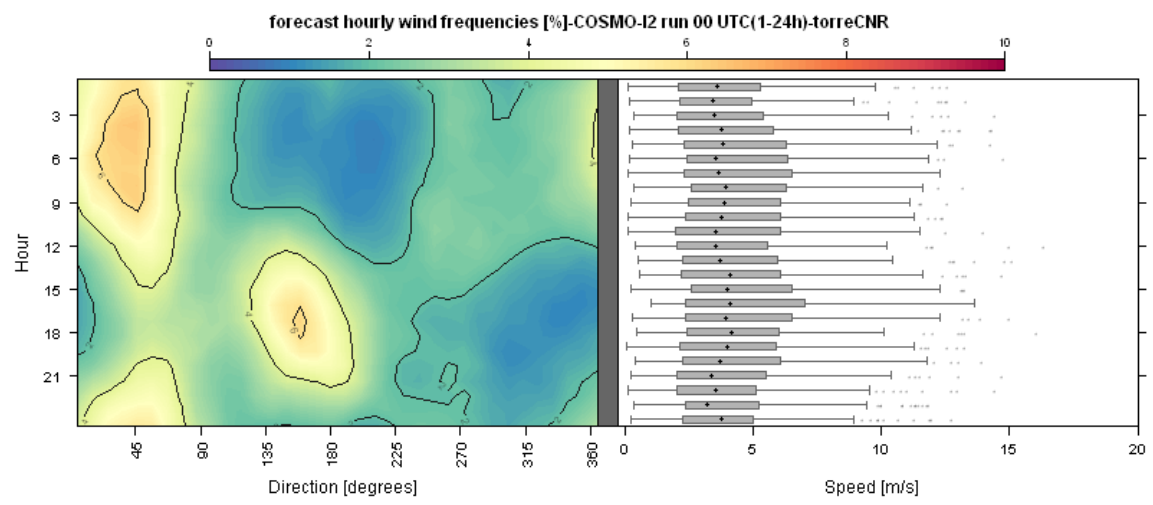
"Torre CNR"



observation



Overestimation of speed in the morning, better in the afternoon



COSMO-I2 day 1

Conclusion and ideas to continue the work

- This is a preliminary study, to learn something from the results more work is needed to separate season, select more reliable stations
- For example, using “windcontour-plot type”
 - ▣ Plot 2m temperature together with direction for breeze onset investigation
 - ▣ Plot wind speed errors (ME /MAE) together with direction
- Study significant wind changes between two time steps, not related to diurnal variations

