Scatterometer and NWP model data in regional seas

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Motivations

There is a request from local agencies and oceanographic institutions to use the scatterometer winds for applications, for instance for applications like the Storm Surge forecasting.

Established facts:

- ***The ability of the scatterometer winds to describe several meso-scale atmospheric phenomena in small regional seas, especially where the interaction air flow - orography is strong: 12.5 km grid is ok***

- ***the temporal sampling is still poor (about twice per day) to be able to use them as forcing in the oceanographic models***

- ***In our knowledge, scatterometer data assimilation in the Limited Area Models is still an issue***

Thus:

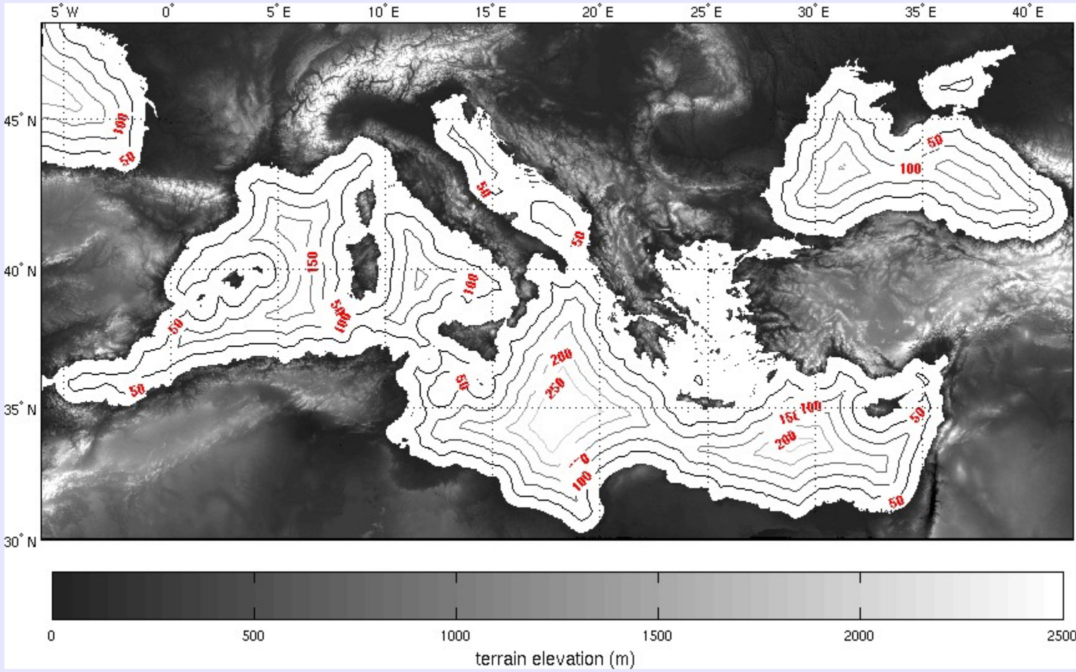
Scatterometer winds may help to understand to what extent numerical weather prediction models perform in small regional seas, and if and how their performances depend on geophysical conditions and/or wind characteristics.

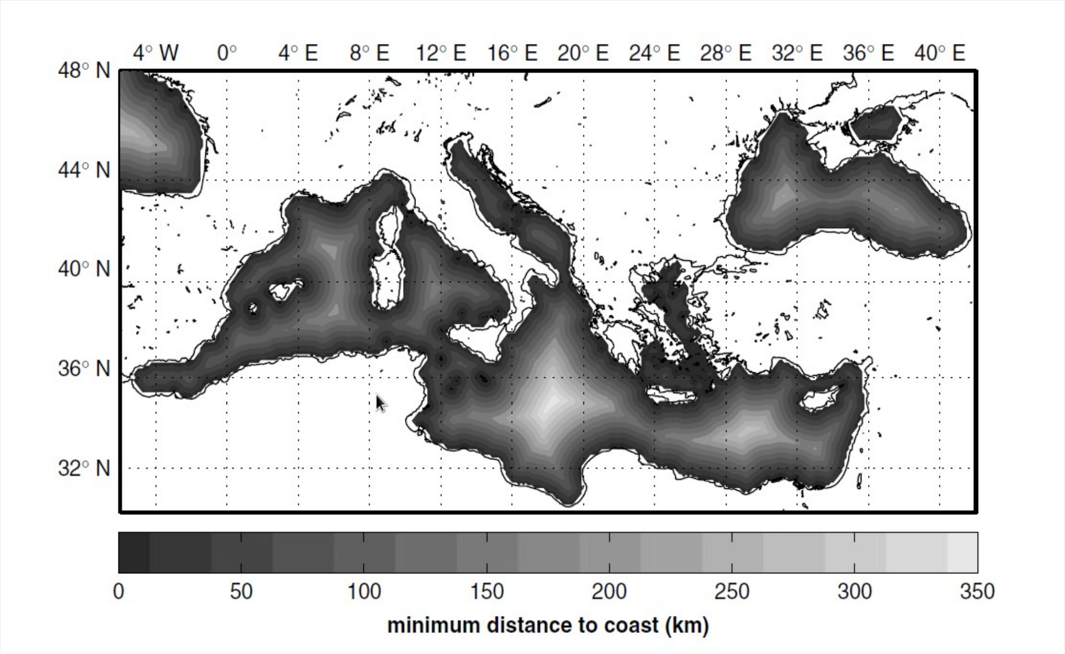
Aims

This led us to investigate the performances of both LAM and Global NWP models over the Mediterranean Basin through a comparison with scatterometer winds with the following aims:

1.To understand where, when and why discrepancies occur

2.Provide simple methods to take into account of the differences for Storm Surge forecasting in the Adriatic Sea (*see poster)*





50% of the Mediterranean Sea is less than 50 km from coastline 90% less than 150 km

Outline

- Mean wind speed bias (Scatt-ECMWF): global, local and temporal characteristics
- Mean wind vorticity bias: global and local characteristics
- Conclusions

Details of this presentation are in

Accadia et al., MWR, 2007, Zecchetto, De Biasio and Accadia, QJRMS, 2012, Zecchetto and Accadia, QJRMS, 2014

Data used

The ECMWF wind data: surface analysis fields at 25 km (T799) and at 16 km (T1279) equivalent grid size, available at synoptic hours (00:00, 06:00 UTC, . . .). They have been matched to the scatterometer winds by linear interpolation to the scatterometer overpass time.

Scatterometer data: QuikSCAT L2B Ocean Wind Vector (OWV) 12.5 km and ASCAT L2 OWV12.5 km near-real-time data, downloaded from PO.DAAC.

SST: daily sea-surface temperature maps have (since April 2006) from the Operational Sea Surface Temperature and Sea Ice Analysis (OSTIA) system which uses satellite data operationally provided by the Group for High Resolution Sea Surface Temperature (GHRSST) project at high resolution (1/20°) from PO.DAAC.

Spatial features of normalized bias $<\Delta w_s/w_{sc}>$

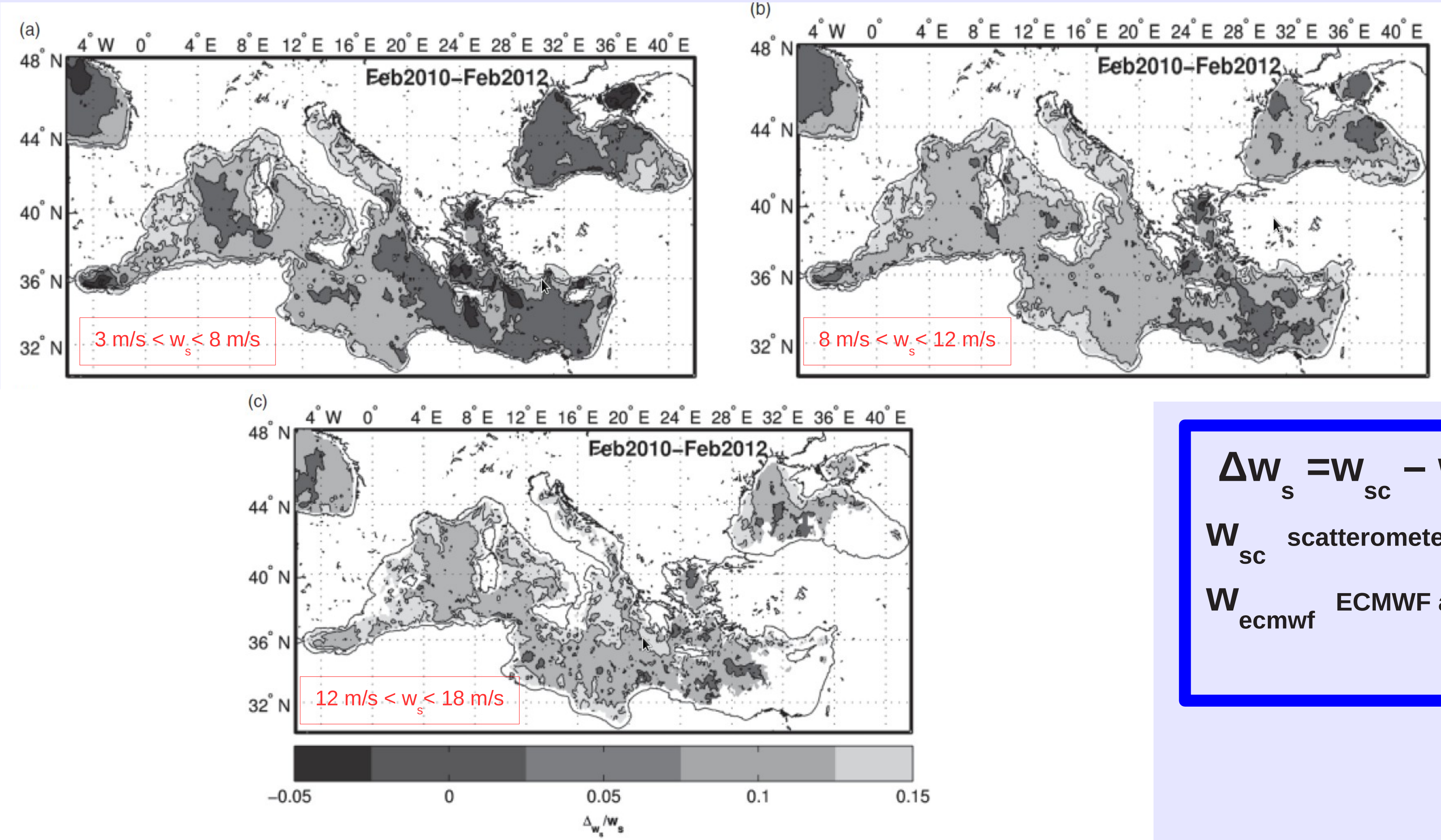


Figure 4. The mean fields of $\overline{\Delta w_s/w_s^{sc}}$ for a prescribed speed range: (a) $3 \le w_s^{sc} < 8\,\mathrm{m\,s^{-1}}$, (b) $8 \le w_s^{sc} < 12\,\mathrm{m\,s^{-1}}$, and (c) $12 \le w_s^{sc} < 18\,\mathrm{m\,s^{-1}}$ over the period February 2010 to February 2012. White areas indicate lack of winds in the given range.

$$\Delta w_s = w_{sc} - w_{ecmwf}$$

w_{sc} scatterometer wind speed

w_{ecmwf} ECMWF analysis wind

Normalized wind speed bias and RMS dependence on distance from coast

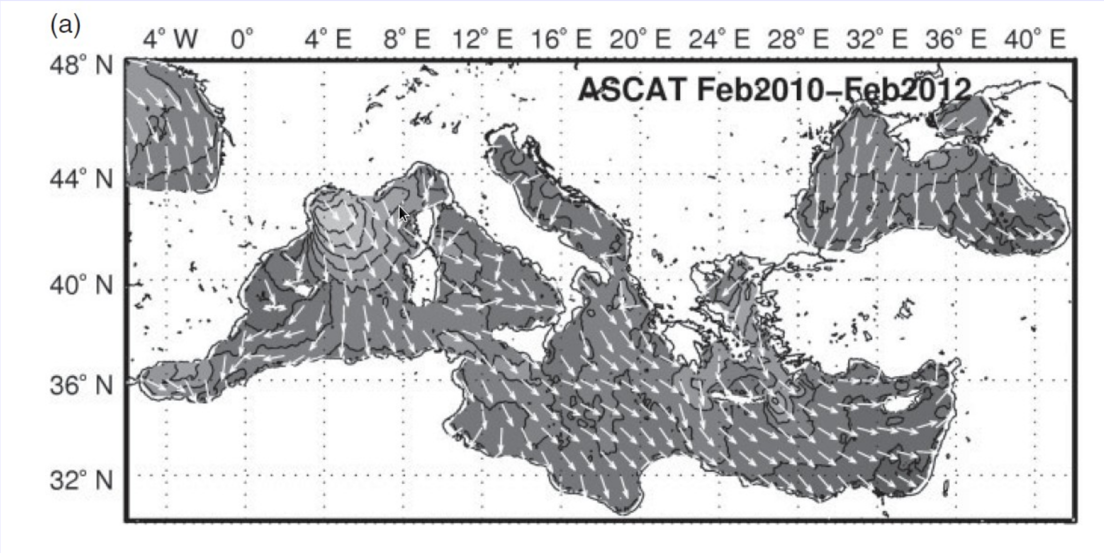


Table 1. Statistics of the ASCAT–ECMWF comparison over the Mediterranean basin for the period February 2010 to February 2012. Basin refers to the whole Mediterranean Sea; coast to the areas between 35 and 60 km from the coast; offshore to the areas >150 km from the coast.

		Basin	Coast	Offshore
$< \overline{\Delta w_s} >$	$\mathrm{m\,s^{-1}}$	0.51	0.56	0.37
$< \overline{RMSD^c_{w_s}} >$	$\mathrm{m\,s^{-1}}$	1.36	1.43	1.19
$< \overline{\Delta w_s / w_s^{sc}} >$		0.07	0.07	0.04
$< \overline{RMSD^c_{w_s} / w_s^{sc}} >$		0.23	0.24	0.19
$< \overline{R_{w_s}} >$		0.88	0.87	0.91
$< \overline{\Delta\theta} >$	°	−2.4	−2.6	−2.3
$< \overline{RMSD^c_\theta} >$	°	22.8	24.4	19.2
$< \overline{R_\theta} >$		1.77	1.74	1.80

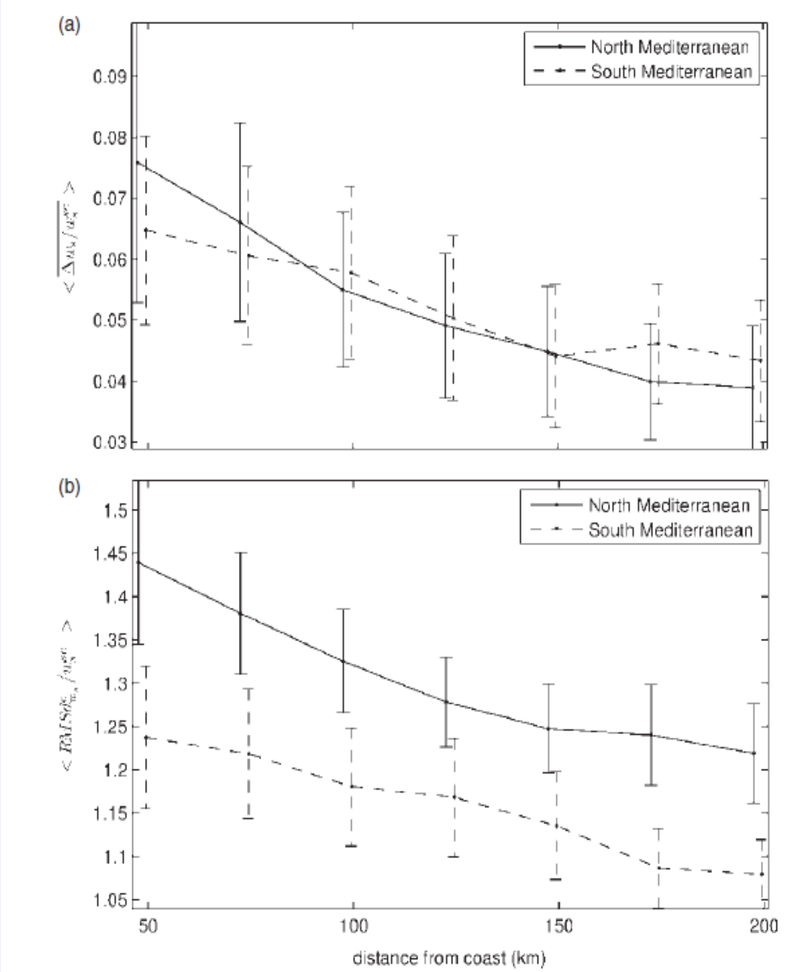
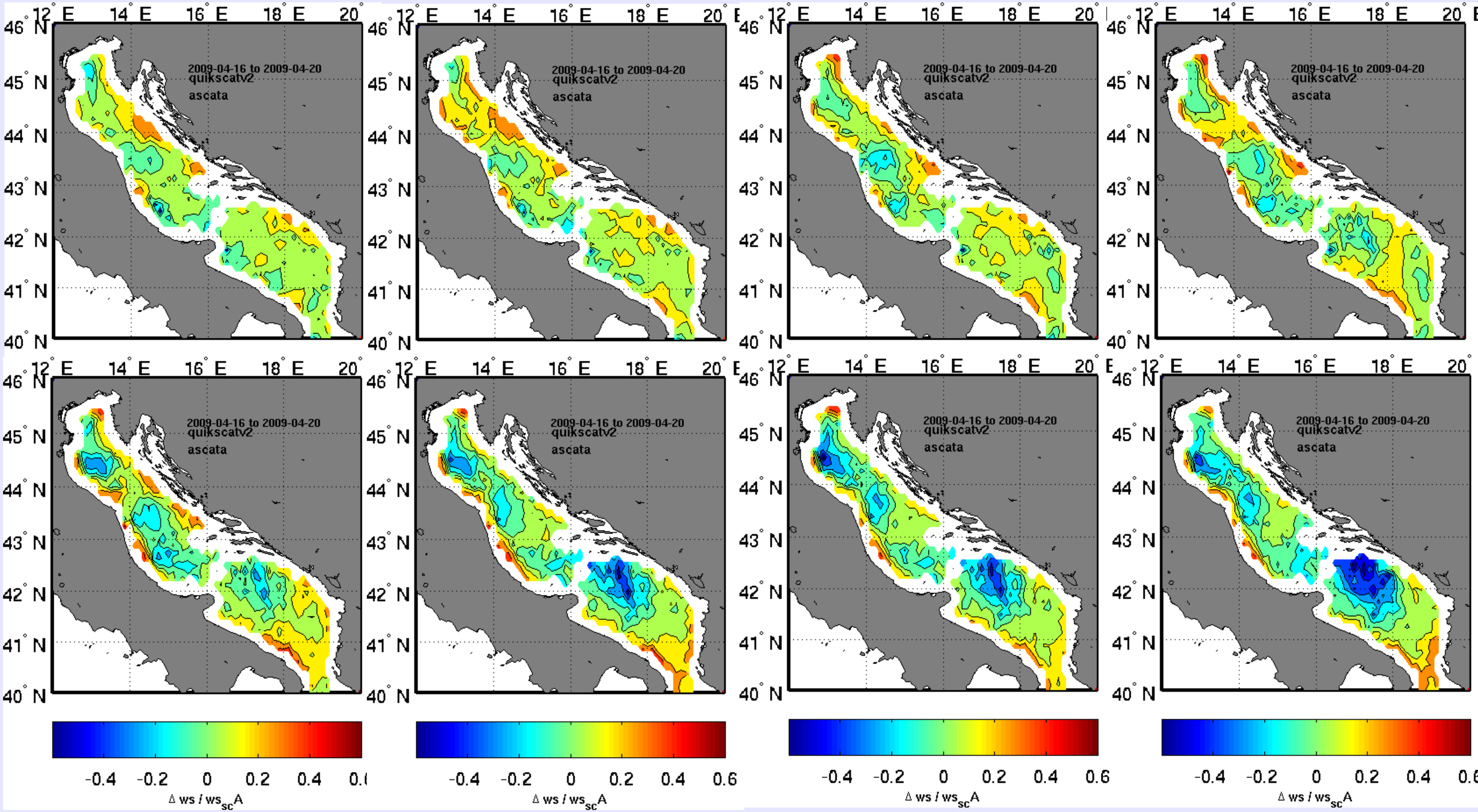


Figure 6. (a) $< \overline{\Delta w_s / w_s^{sc}} >$ and (b) $< \overline{RMSD^c_{w_s} / w_s^{sc}} >$ as a function of the minimum distance from the coast for the northern (solid line) and southern (dashed line) Mediterranean Sea (see text). Vertical bars indicate one standard deviation. Southern lines have been slightly shifted along the *x* axis for the sake of clarity.

<$\Delta w_s / w_{sc}$> over 4 days as running mean at 1 day step



The mean relative wind vorticity

Main reasons why we investigated the relative wind vorticity (hereafter vorticity)

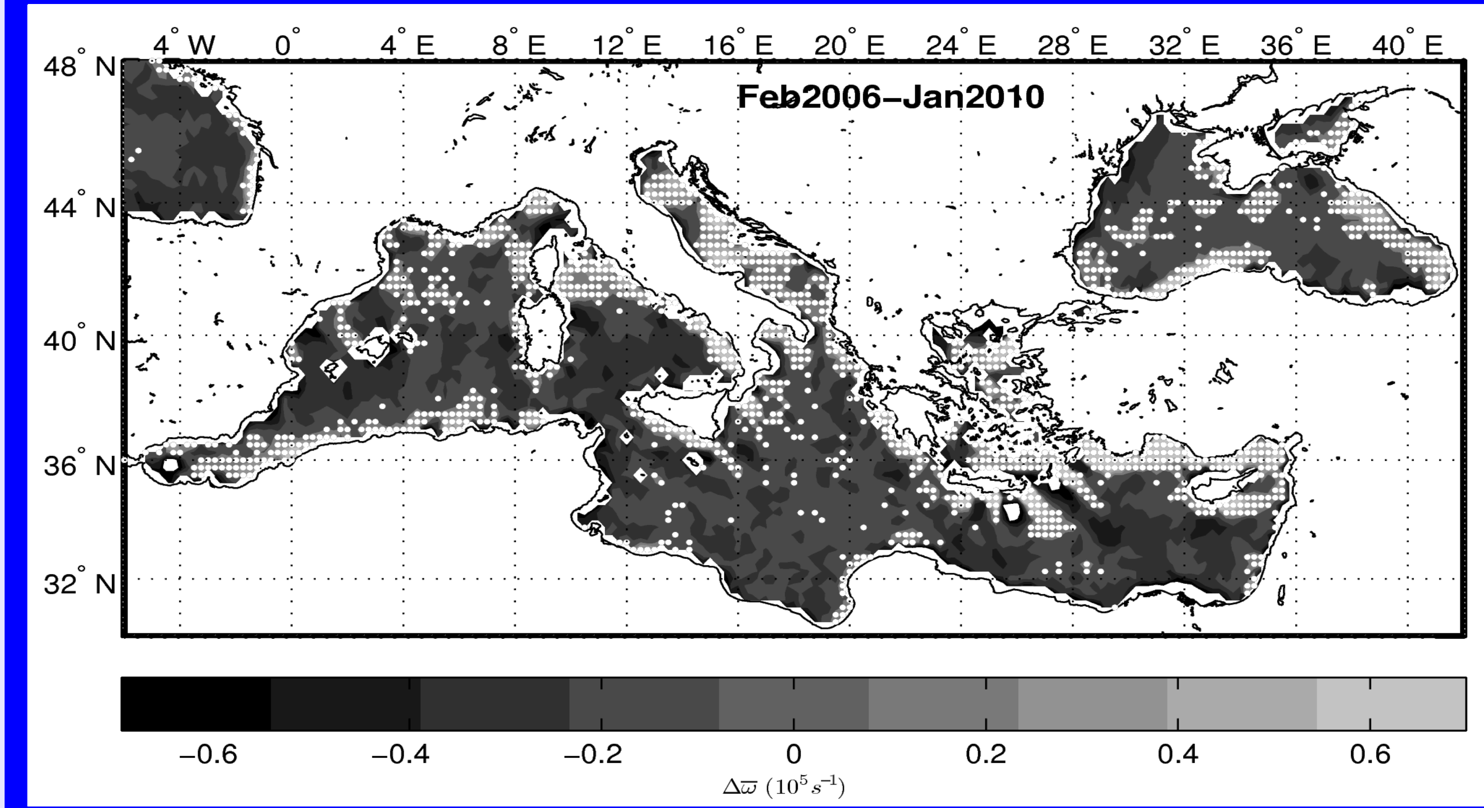
1. It is a crucial parameter to understand the spatial features of the wind field, particularly interesting where interactions between the air flow and the orography occur

2. It is important from the oceanographic point of view, as several cyclonic and anti-cyclonic ocean eddies are sustained by persistent cyclonic or anti-cyclonic circulations in the atmosphere

3. It cannot be measured directly

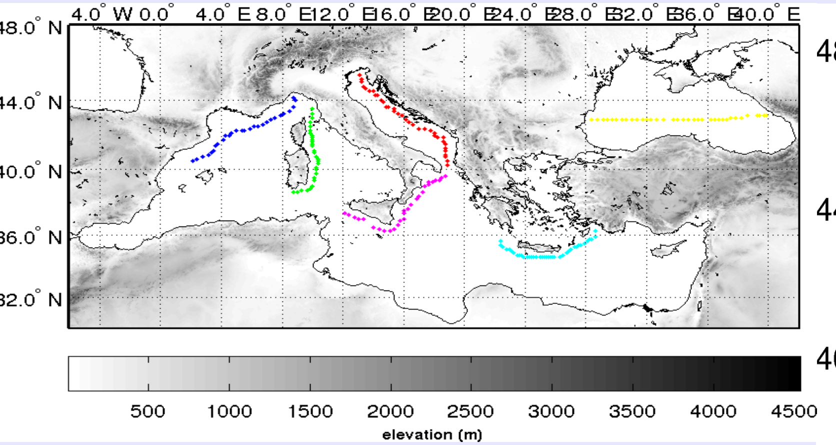
So, we did comparisons between the wind vorticity derived from QuikSCAT data and that derived from ECMWF analysis T799 winds.

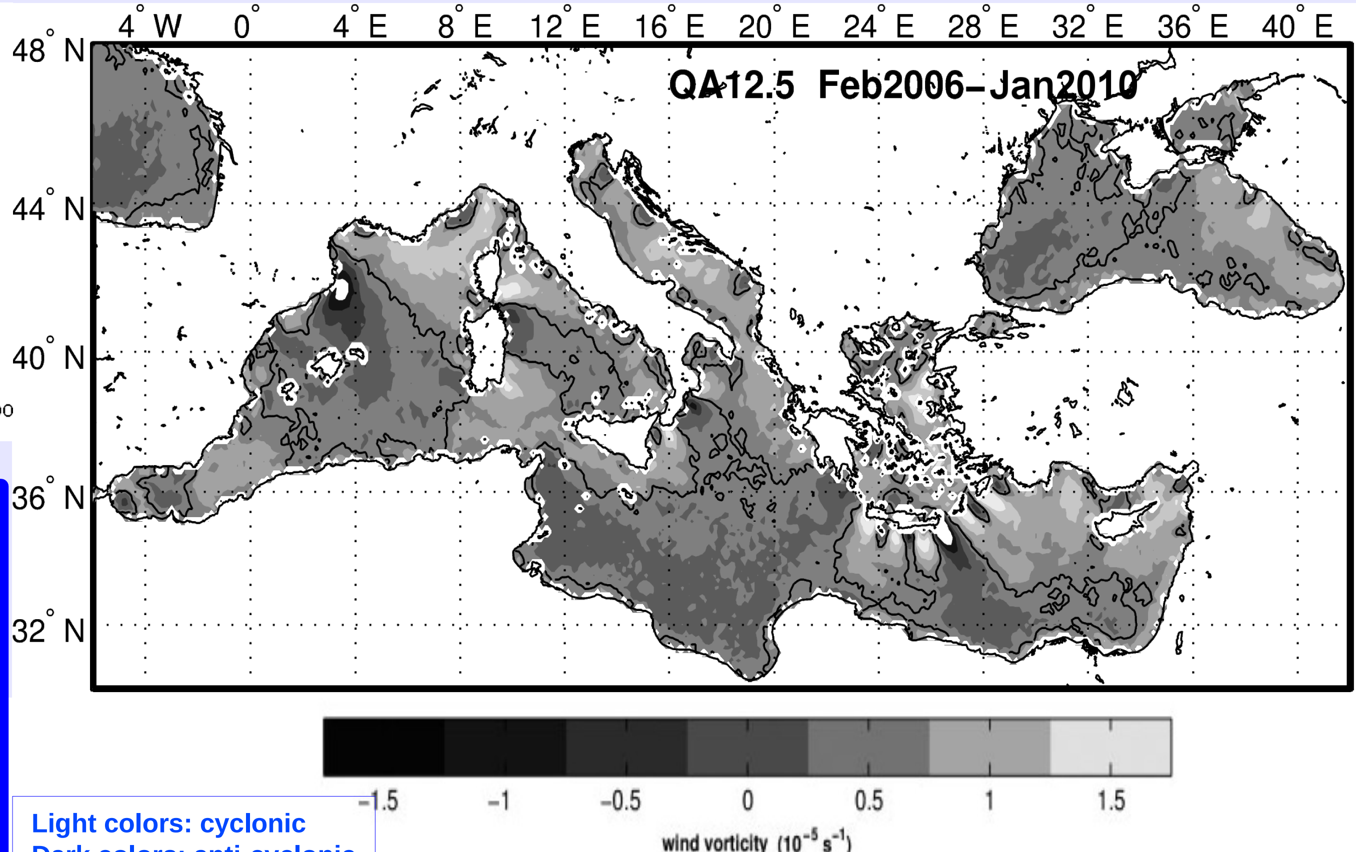
Spatial distribution of mean vorticity differences



Field of the vorticity relative bias **Δω** (Qscat-ECMWF). White indicates the areas with **Δω** > 0. Grid spacing: 0.25° by 0.25°.

Mean wind vorticity: local characteristics



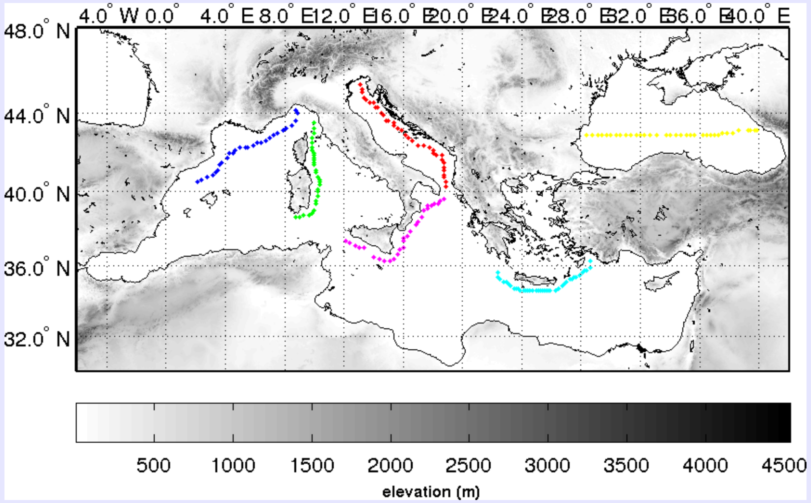


Light colors: cyclonic
Dark colors: anti-cyclonic

Figure 4. Mean wind vorticity field $\overline{\overline{\omega}}$ over the period 2006–2010. (a) $\overline{\overline{\omega}}^{sc}$ from 12.5 km grid data. (b) $\overline{\overline{\omega}}^{e}$ from 25 km grid data. Solid lines indicate zero vorticity.

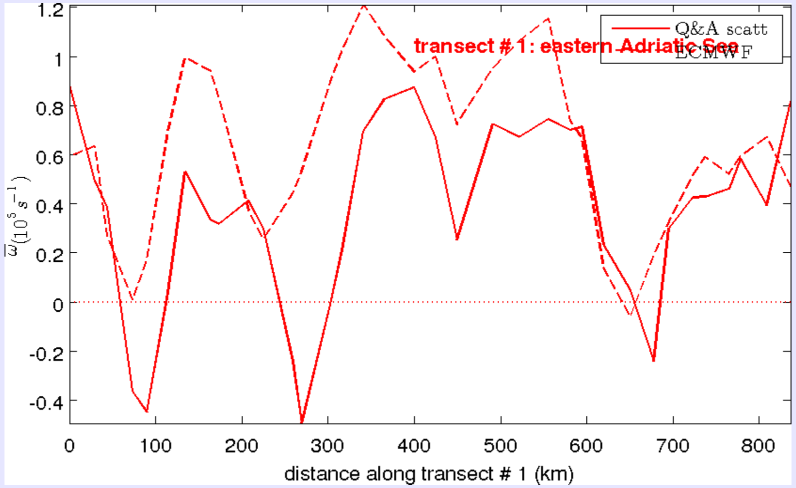
The mean vorticity field, ***positive for cyclonic and negative for anticyclonic circulations***, reveals several local features: a small cyclonic circulation inside a larger anticyclonic area in the Gulf of Genoa (44°N, 9°E) related to local cyclogenesis, and the alternation of cyclonic and anticyclonic circulations in the eastern Adriatic Sea and south of the Crete Island (35°N, 23°E–28°E) due to the wind-flow disturbances induced by orography.

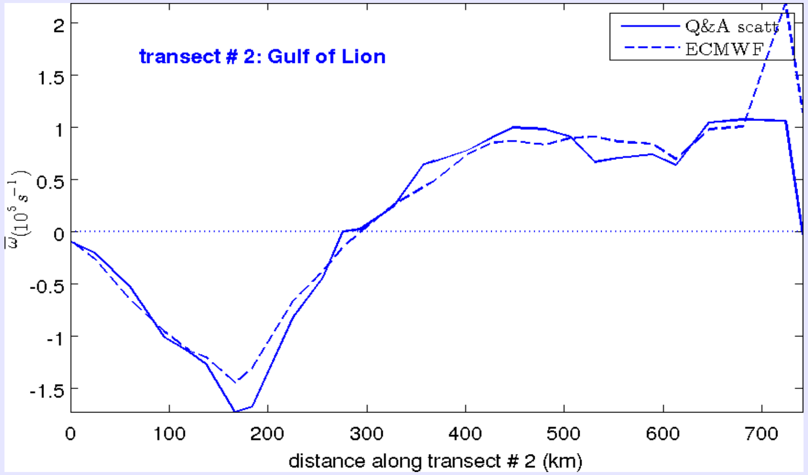
Mean wind vorticity: local characteristics



<u>Adriatic Sea:</u>

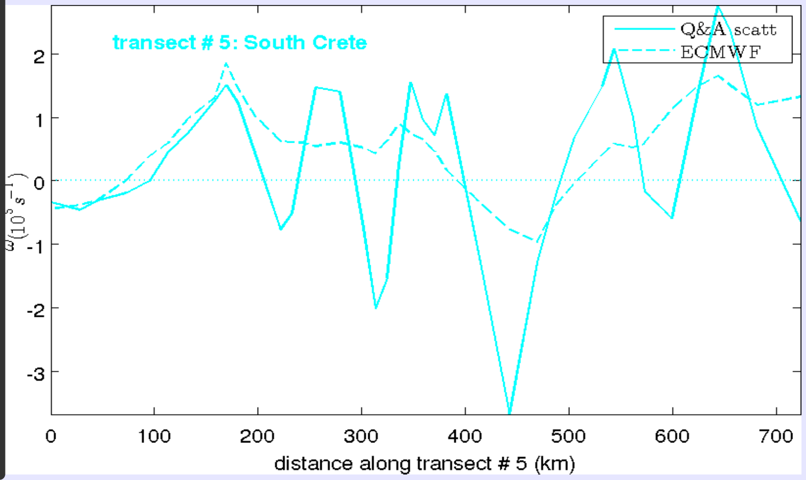
ω_e and ω_{sc} have similar variability, but ω_e remains almost cyclonic, then unable to describe the alternation of cyclonic and anticyclonic areas mainly produced under north-eastern winds.





<u>South of the Crete island:</u>

the circulations described by ω_{sc} have spatial scales not resolved by ω_e, which shows only four of the ten vorticity circulations shown by ω_{sc}.



<u>Gulf of Lion:</u>

ω_{sc} and ω_e are very similar. The vorticity has a large-scale variability around 150–500 km. Also the places where the vorticity changes sign are well represented by ω_e.

Concluding remarks

- **$<\Delta w_s/w_{sc}>$ decreases from coast to offshore (35 km to 200 km) and both in the north and south parts of the basin. This confirms the influence of the orography (north) but also of the sea-land transition processes (south), claiming for an important role of the land/sea breezes**

- **Similar results have been obtained analysing LAM wind fields and confirmed in the analysis of the wind relative vorticity**

- In the short term (less than 10 days) and for small regions like the Adriatic Sea $<\Delta w_s/w_{sc}>$ can range as ± 50% over space and time.

- These differences should be taken into account when atmospheric model winds are used as forcing in the oceanographic numerical predictions, like those for the Storm Surge, where wind is of paramount importance (again see poster *The eSurge-Venice project: how scatterometer data can improve the storm surge forecasting in the Gulf of Venice*)