An Evaluation Study for Improving Gap Flow Simulations in Coastal Areas on Portugal

NORSEWIND
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CLS
COLLECTE LOCALISATION SATELLITES

LNEG
Laboratório Nacional de Energia e Geologia, I. P.
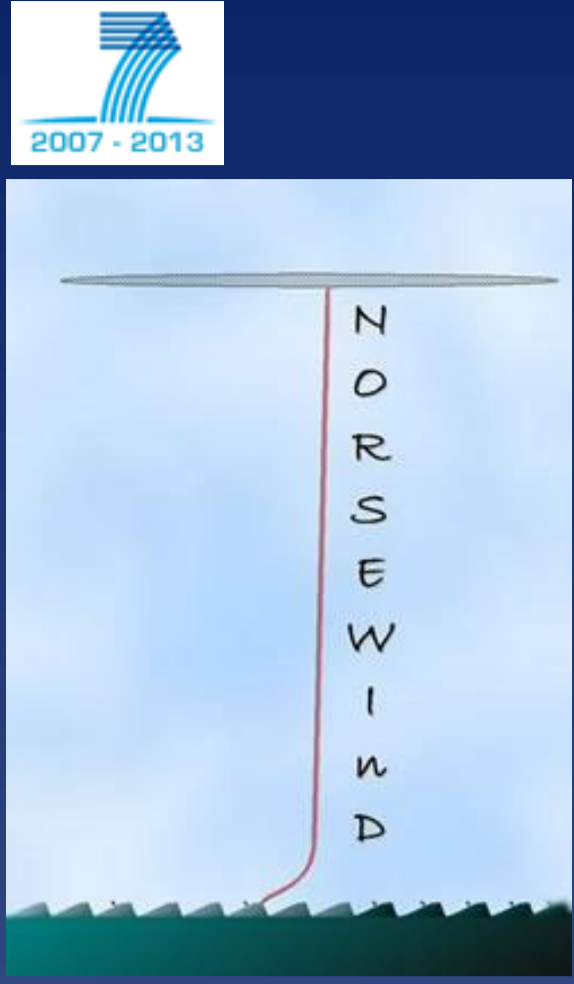
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GOVERNO DE PORTUGAL · MINISTÉRIO DA ECONOMIA E DO EMPREGO

INTRODUCTION

Winds inferred by Synthetic Aperture Radar (SAR) satellites are a very important source of spatial wind field behavior along coastal areas particularly on small coastal areas that are temporary affected by strong flow disturbances mainly driven from land to the ocean. Gap flow circulations, among others, are an example of such wind phenomena disturbances which are not yet described by regional atmospheric models nor by CFD modeling. Such situations could compromise both offshore wind resource and park deployment studies on places affected by the presence of these phenomena types. A possible way to overcome this situation is the usage of SAR images assimilated into regional atmospheric models using certain type of assimilation techniques. In this work, a real case occurred in a coastal area in Portugal will be taken into account. A strong gap flow occurred during the beginning of the night 9 December 2010 was captured by a SAR image which was assimilated into the model. Some validation meteorological stations were used for validation purposes taken into account scenarios performed with and without wind SAR assimilation. Spatial results lead to the conclusion that the assimilation of SAR images improves the wind pattern results which reflects how SAR assimilation into the mesoscale models are important for simulating the coastal wind flow patterns.

Panel 1 — Satellite work

1) Study of gap flows …

During the day - 9 December 2010 - gap flows developed along some western coastal regions of Continental Portugal

Gap flows are locally generated wind currents that spread abruptly to the ocean, triggered by non-linear atmospheric phenomena.

Its intensity (strong wind speeds) could bring several impacts on near coastal offshore wind parks.
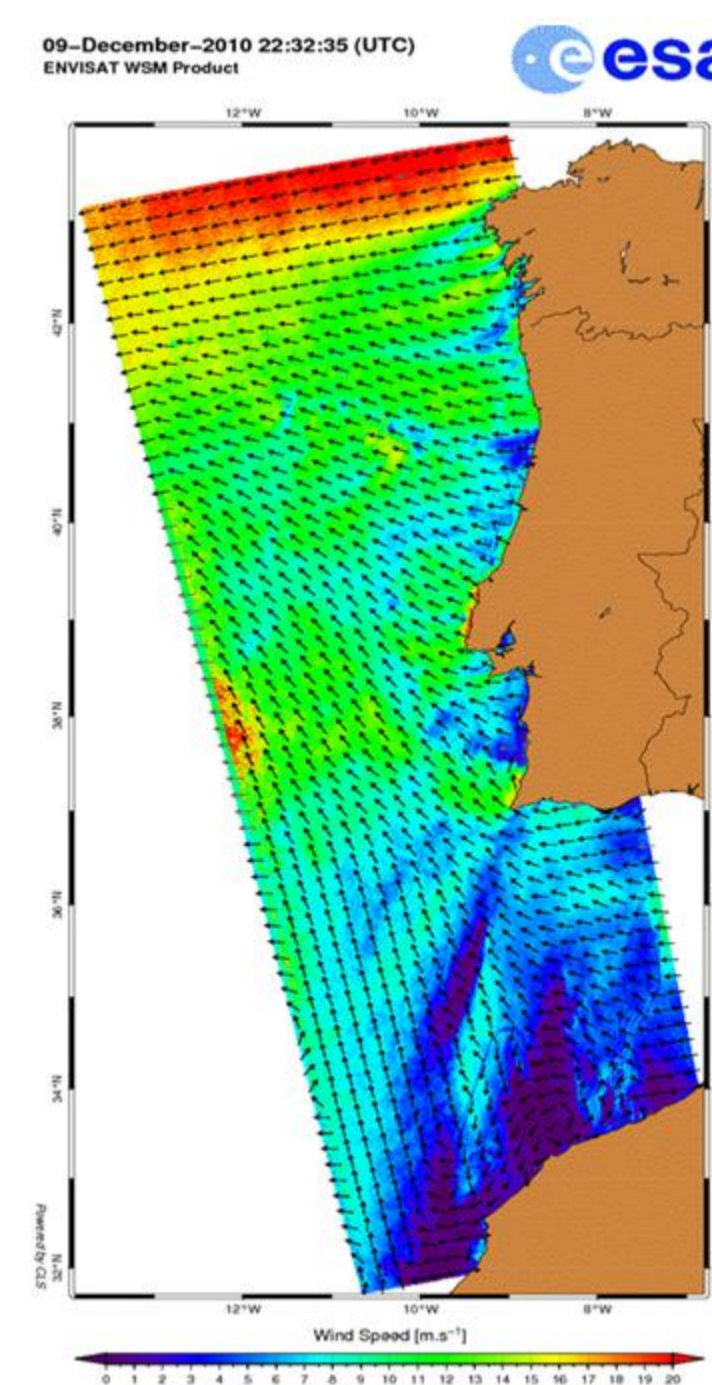
Panel 2 — Satellite work

1) Study of gap flows …

A high resolution satellite image (e.g. SAR) is a good observational wind source "tool" to identify the occurrence of strong wind regimes around coastal areas.

Generally, mesoscale models, do not reproduce in an efficient way, gap flows, specially, the ones very near to the coasts.

Could SAR images, ingested into the mesoscale model, improve gap flows simulations??

09-December-2010 22:32:35 (UTC)
ENVISAT WSM Product

Panel 3 — Satellite work

1) Study of gap flows …

the phenomena in action…

This "zoomed" SAR image on day, 9 December 2010 @ ~ 22:30h shows the gap flows (surface).

"red zones" wind speeds ~ 20 to 30m/s
"green zones" – vicinity ~ 10 to 13 m/s
"blue zones" -around ~ 3 to 6 m/s

09-December-2010 22:32:35 (UTC)
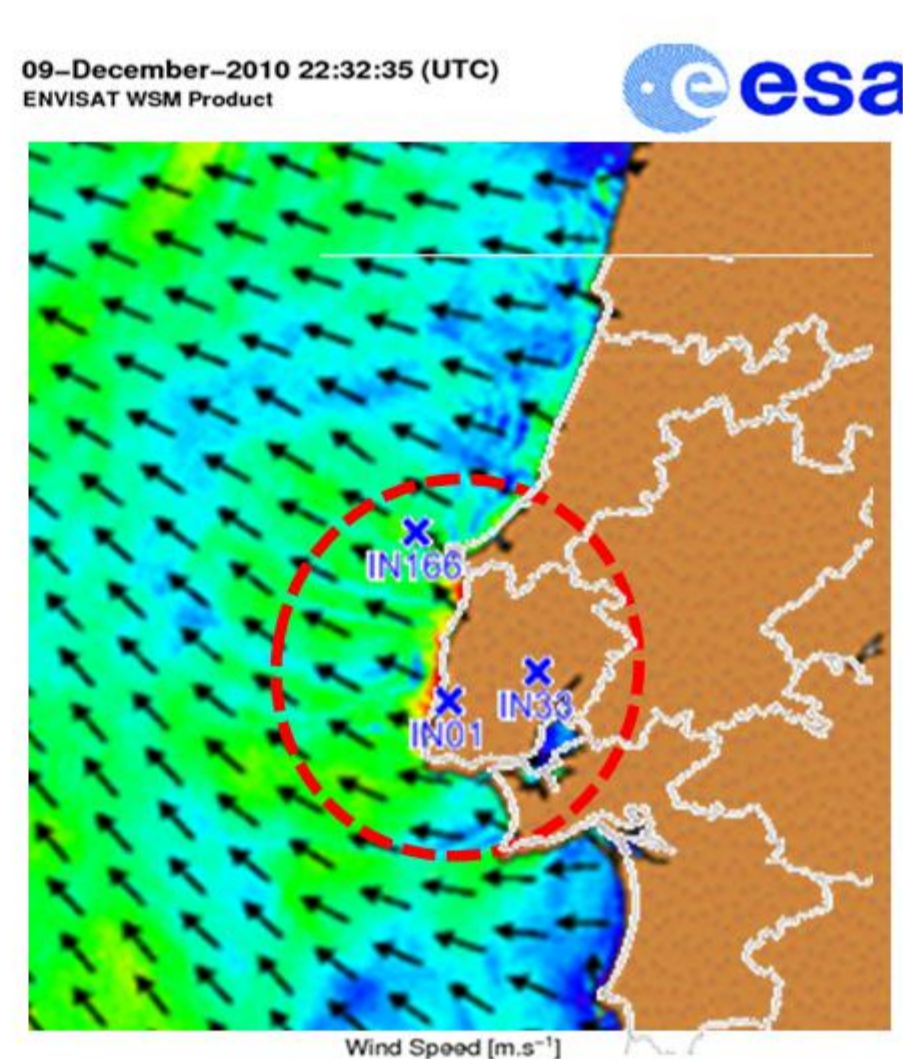ENVISAT WSM Product
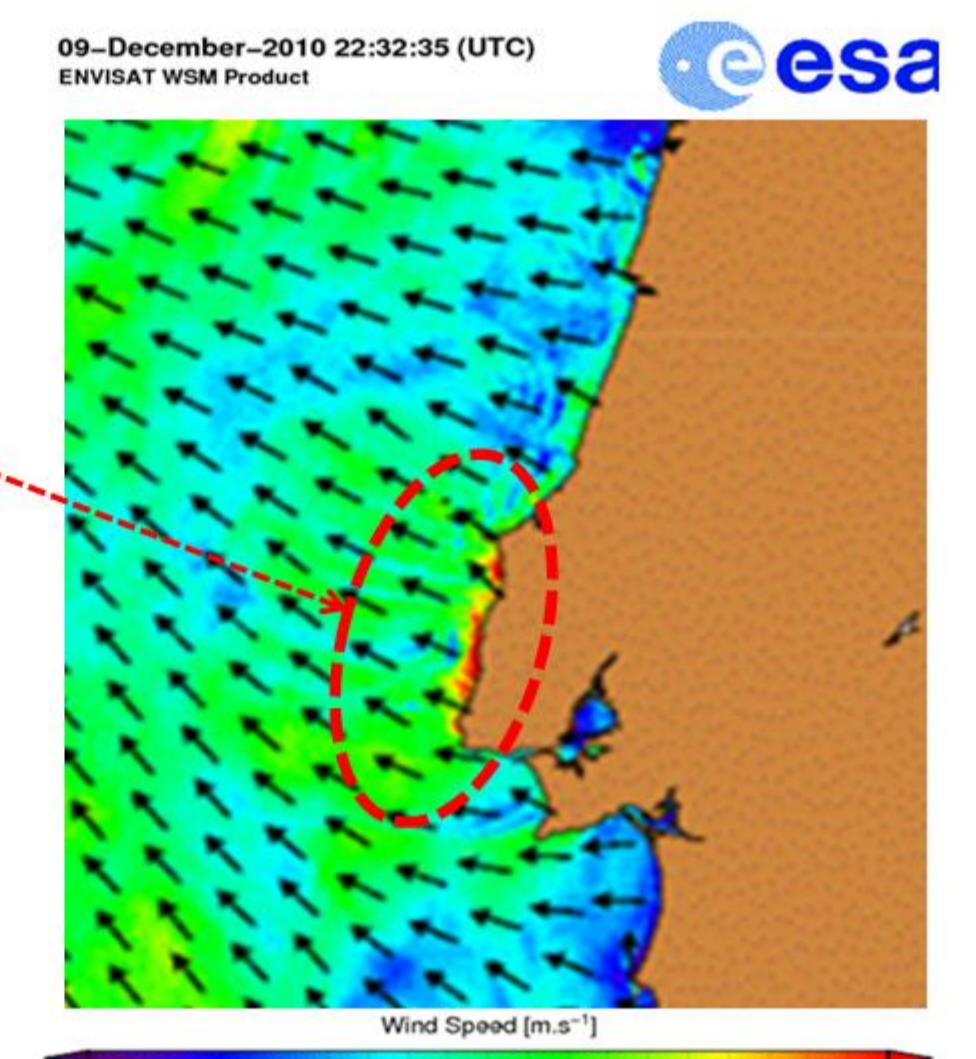
Panel 4 — Satellite work

1) Study of gap flows …

LNEG has three met masts operating around the region. At that day & time, observed mean wind speed and direction values on each was:

IN01 (sensor height 10m):
~ 9.86 m/s ; ~ 90°

IN33 (sensor height 10m):
~ 8.76 m/s ; 65°

IN166 (sensor height 21m):
~ ? m/s ; ?°

09-December-2010 22:32:35 (UTC)
ENVISAT WSM Product
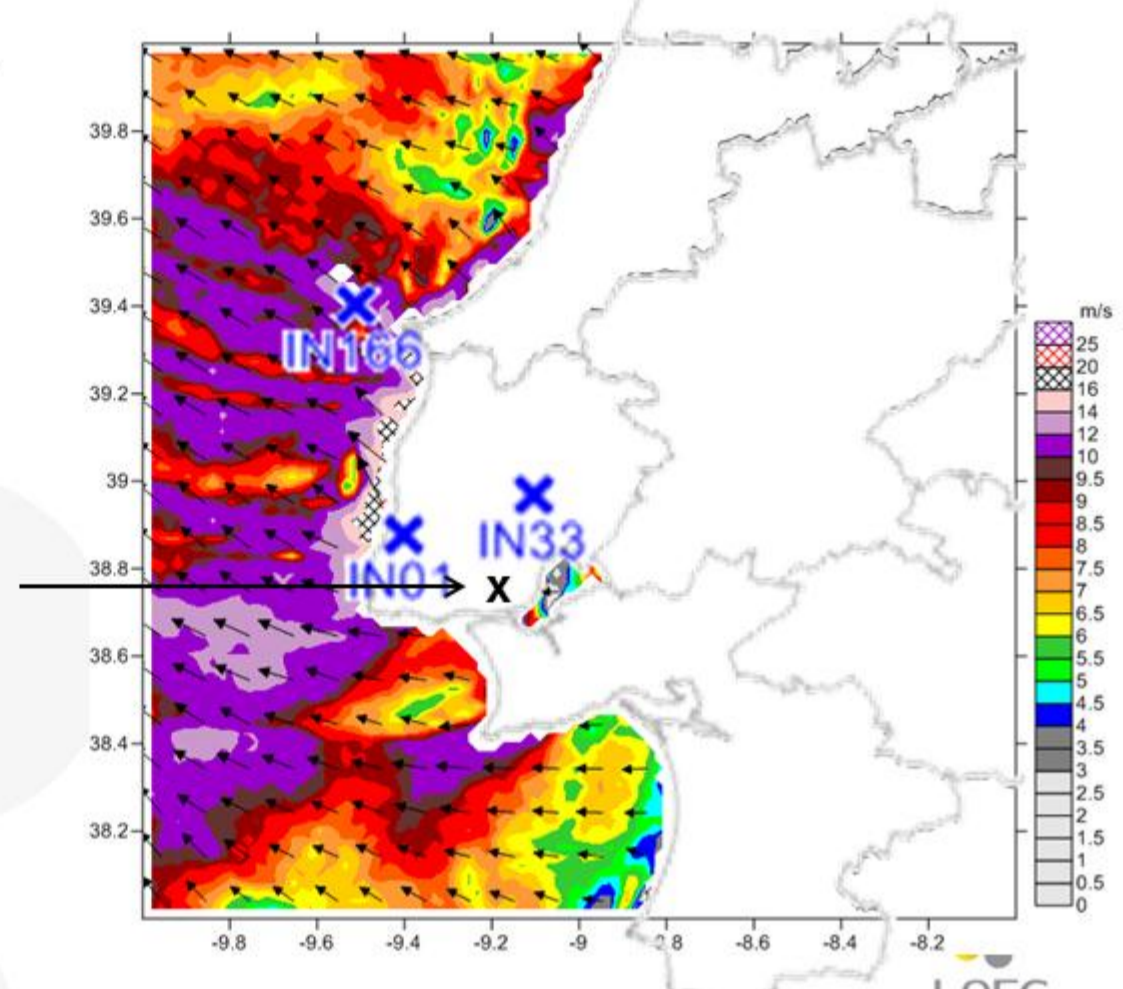
Panel 5 — Satellite work

2) Setup WRF model …
As a background "run"

- Three domains covering the area under study; 50x50km ; 10x10km and 2x2km;

- Historical initial and boundary conditions from GFS forecast model @ 0.5x0.5°, ingested every three hours;

- Running period:
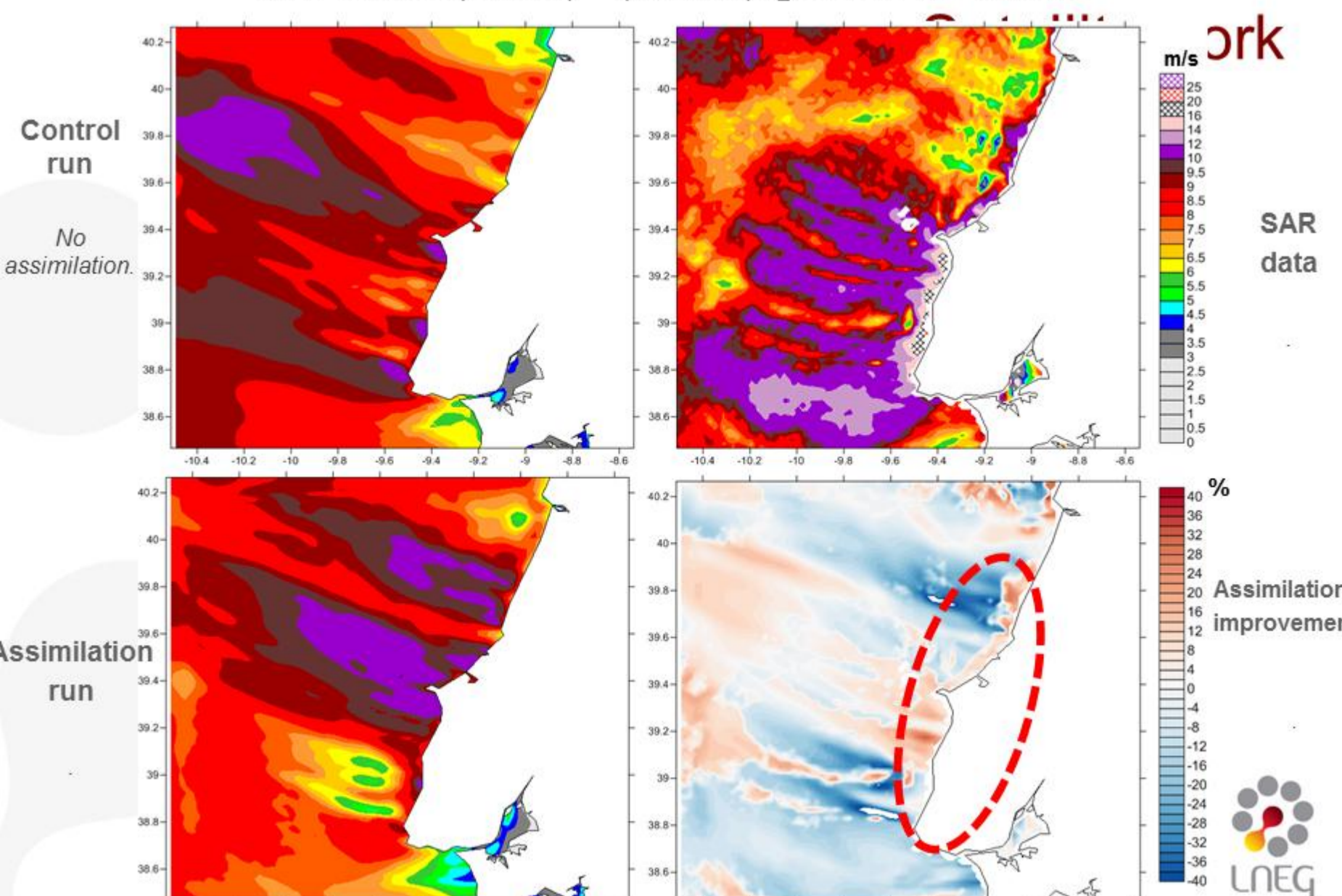1 day - 1200h 09-12-2010 to 1200h 10-12-2010

D03 @ 2x2km

Panel 6 — Satellite work
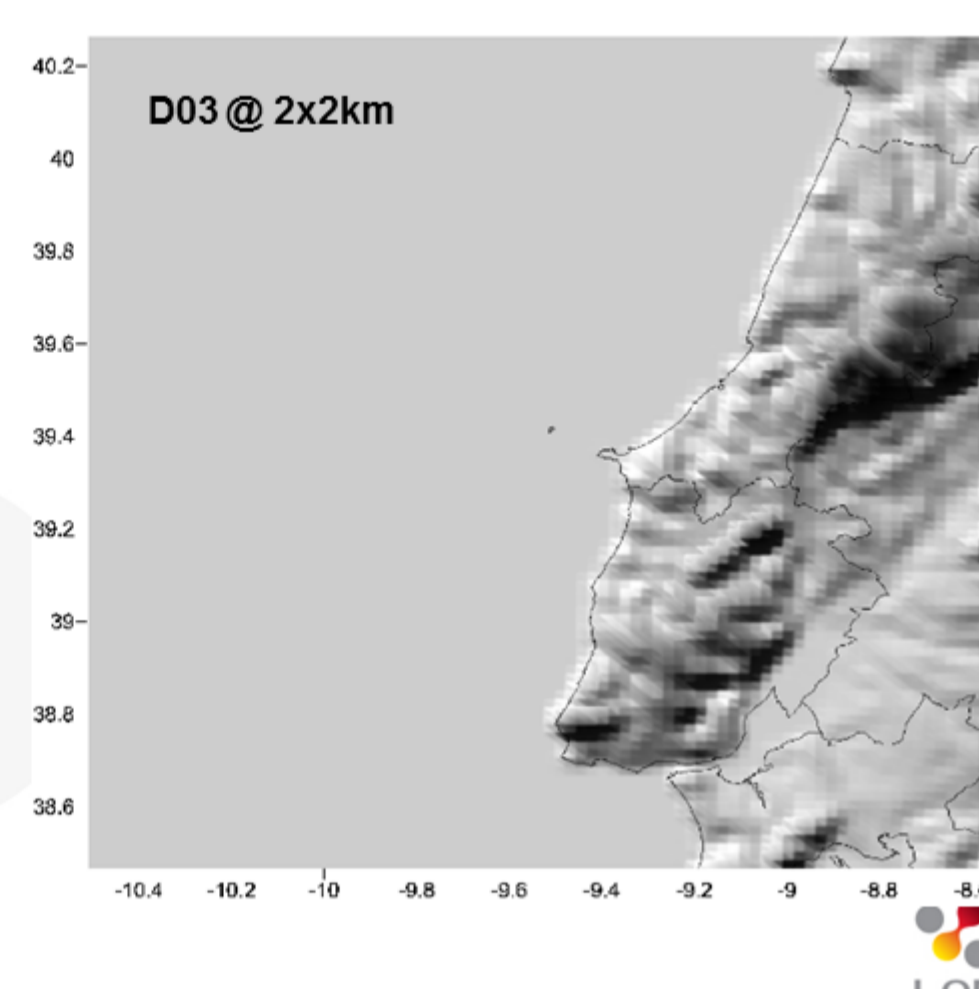
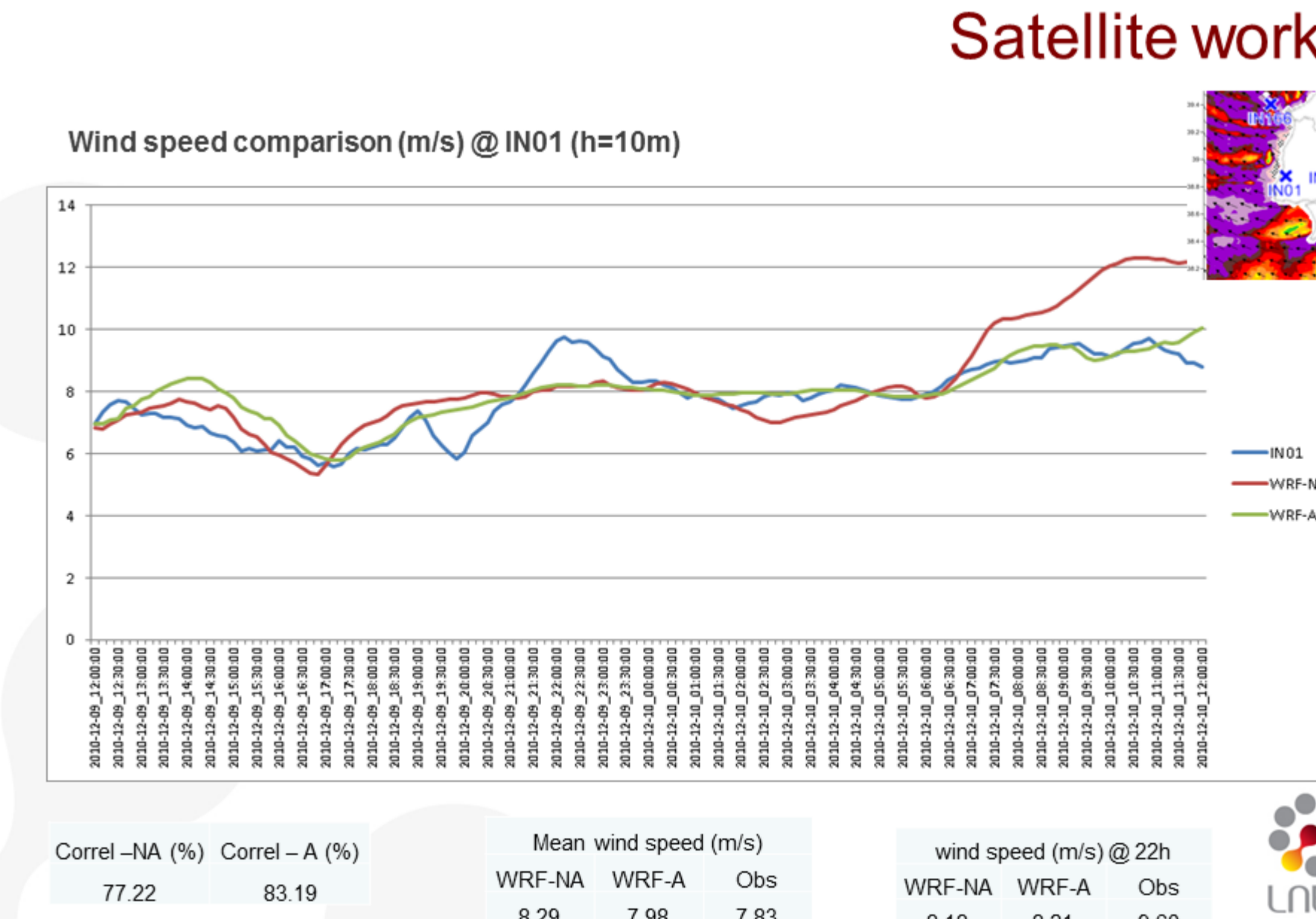**2) Setup WRF model …**
Assimilation "run"

- "SAR" wind data image - 2200h (09-12-2010) @ all model domains;

- Synoptic data (3 hour interval) from 1 weather surface station (Lisbon)

- Validation results (with and without assimilation) with met masts from LNEG's database

IN166 IN33 IN01

Panel 7

WRF results (2x2km) – (surface) @ 2200h 09-12-2010

Control run — No assimilation

Assimilation run

SAR data

Assimilation improvement

Panel 8 — Satellite work

WRF results (2x2km) – (surface) @ 2200h 09-12-2010

Wind speed comparison (m/s) @ IN01 (h=10m)

IN01
WRF-NA
WRF-A

Correl –NA (%)	Correl – A (%)	Mean wind speed (m/s)			wind speed (m/s) @ 22h		
		WRF-NA	WRF-A	Obs	WRF-NA	WRF-A	Obs
77.22	83.19	8.29	7.98	7.83	8.18	8.21	9.60

Panel 9 — Comments

SAR assimilation improved wind estimates on met station IN01 - very near to the coast.

Validation on met stations IN33 and IN166 (berlengas) still in course!

Positive spatial impacts in the ocean very near to the coast – a better research for this issue should be performed near future, due to its importance.

Other similar coastal phenomena cases should be investigated. Not only in Portugal but also in Northern Sea area whenever possible!

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