On the coupling between COSMO – WAM (- ROMS)

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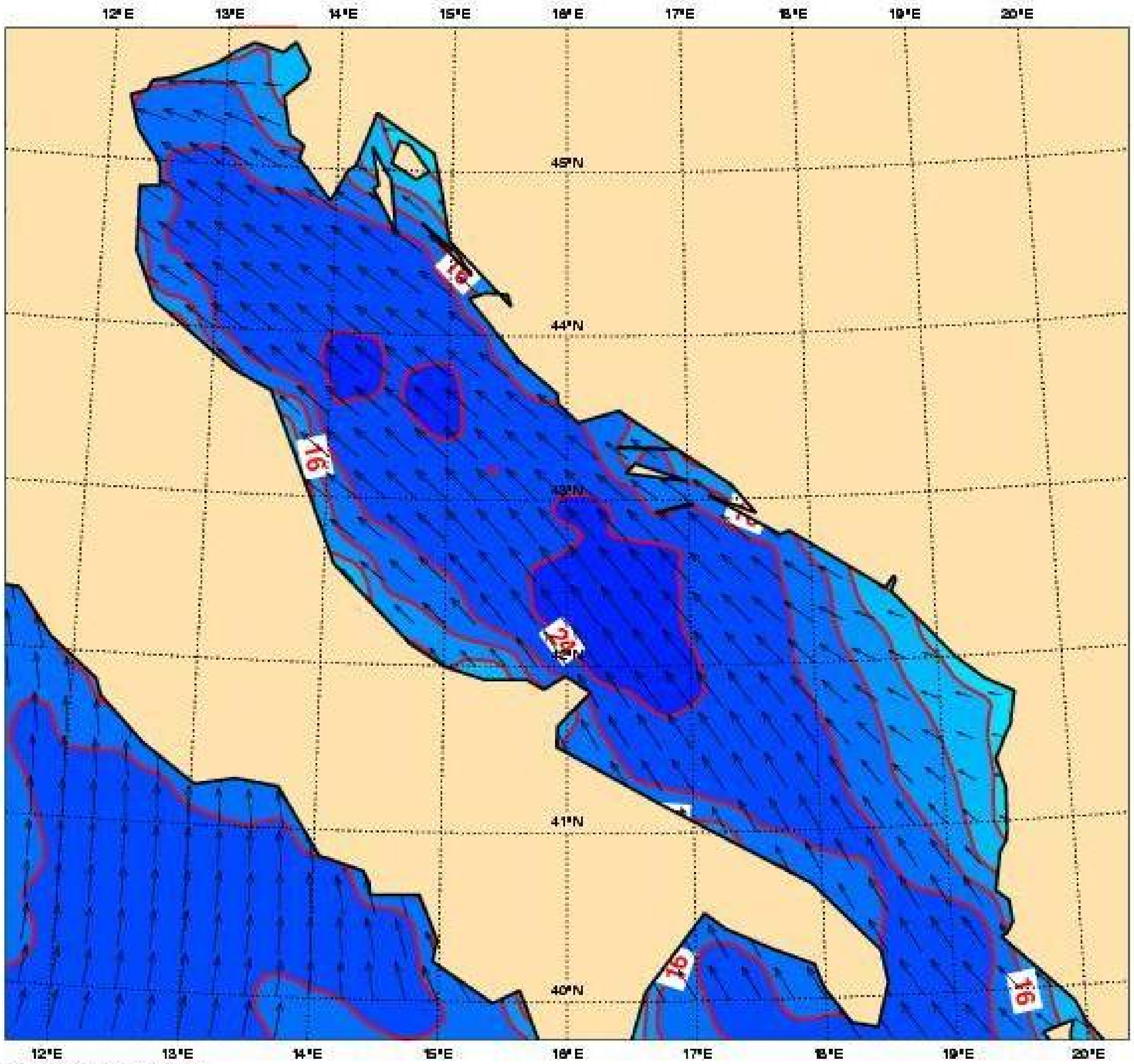

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Motivation

The usefulness of coupling atm-waves has been amply shown
in the open ocean

In the coastal zones the limited depth increases wave steepness and
therefore the air-sea interactions

The implications are felt at a greater extent in the inner and enclosed seas
because of limited fetches and extended coastal zones

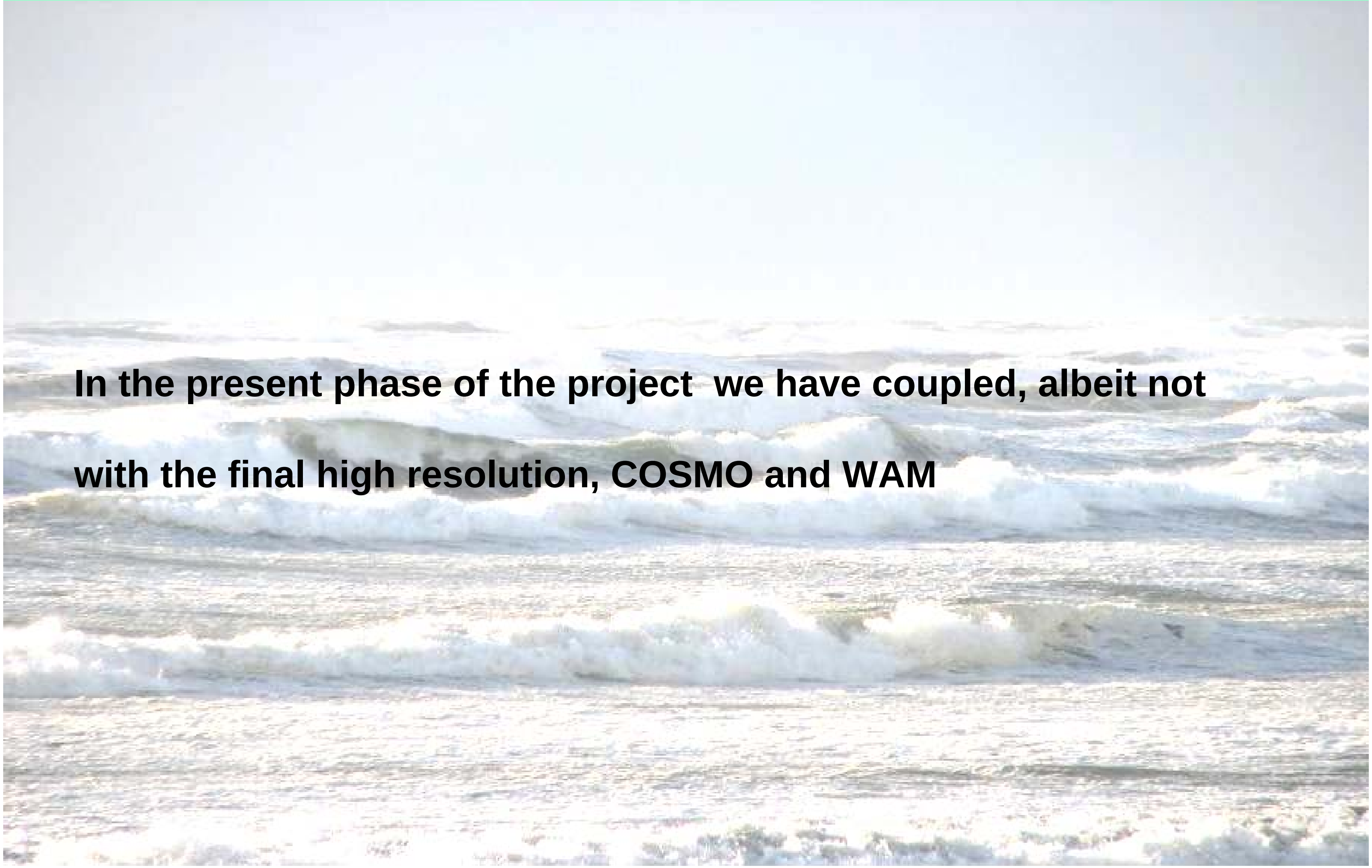
Here the interactions imply also the coastal currents and
the sediment motion

It is therefore natural to extended the coupling to the LAMs –

In oder to model the full cycle our plan is to couple:

WAM (waves)
COSMO (atmosphere)
ROMS (currents and sediments)

Work plan



In the present phase of the project we have coupled, albeit not with the final high resolution, COSMO and WAM

Work in progress

Original plan: to use the MCT (Model Coupling Toolkit) following Warner et al

After some trials and problems, we chose a different approach

A custom made MPI library has been developed suitable for coupling multiple models

At the present stage COSMO and WAM have been two-way coupled and successfully run

Methodology

Given N processors, the technique is to decompose them as

$$N_{ocn} + N_{wav} + N_{atm} = N$$

Computationally, this means to split the MPI_COMM_WORLD into subsets by using the MPI_COM_SPLIT command

Having done that, each model uses a OCN_COMM_WORLD, ATM_COMM_WORLD and WAV_COMM_WORLD

The coupling provides instantaneous values of the fields, i.e. no average is done. Hence the models are fully synchronised.

Grids

Each model is run on its original grid – no need for a common one

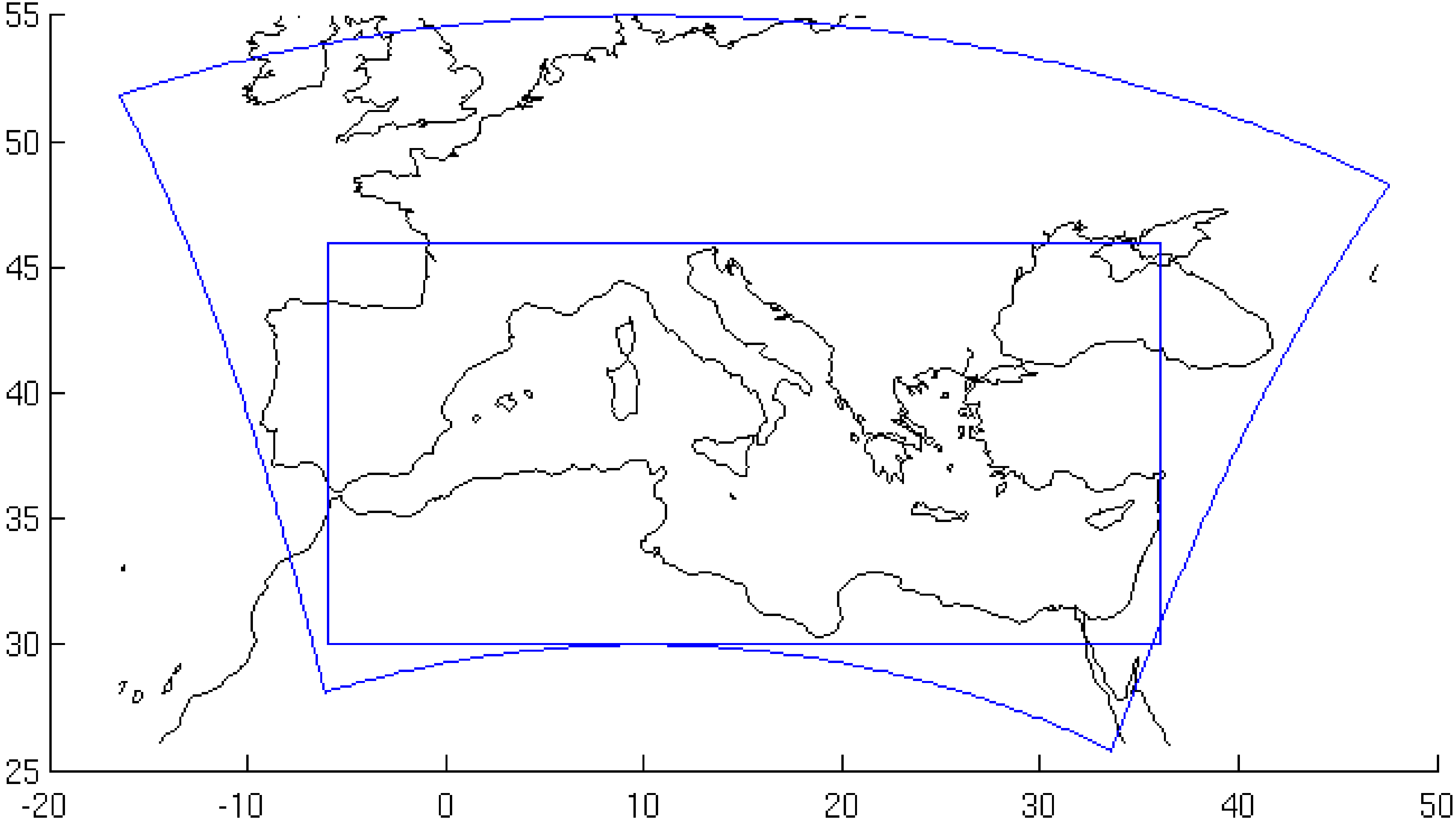
The coefficients of the necessary interpolation are evaluated once forever

Each computational node computes the full matrix. Together with the partition of the processors, this allows each node to know what to pass to and what to expect from each other node

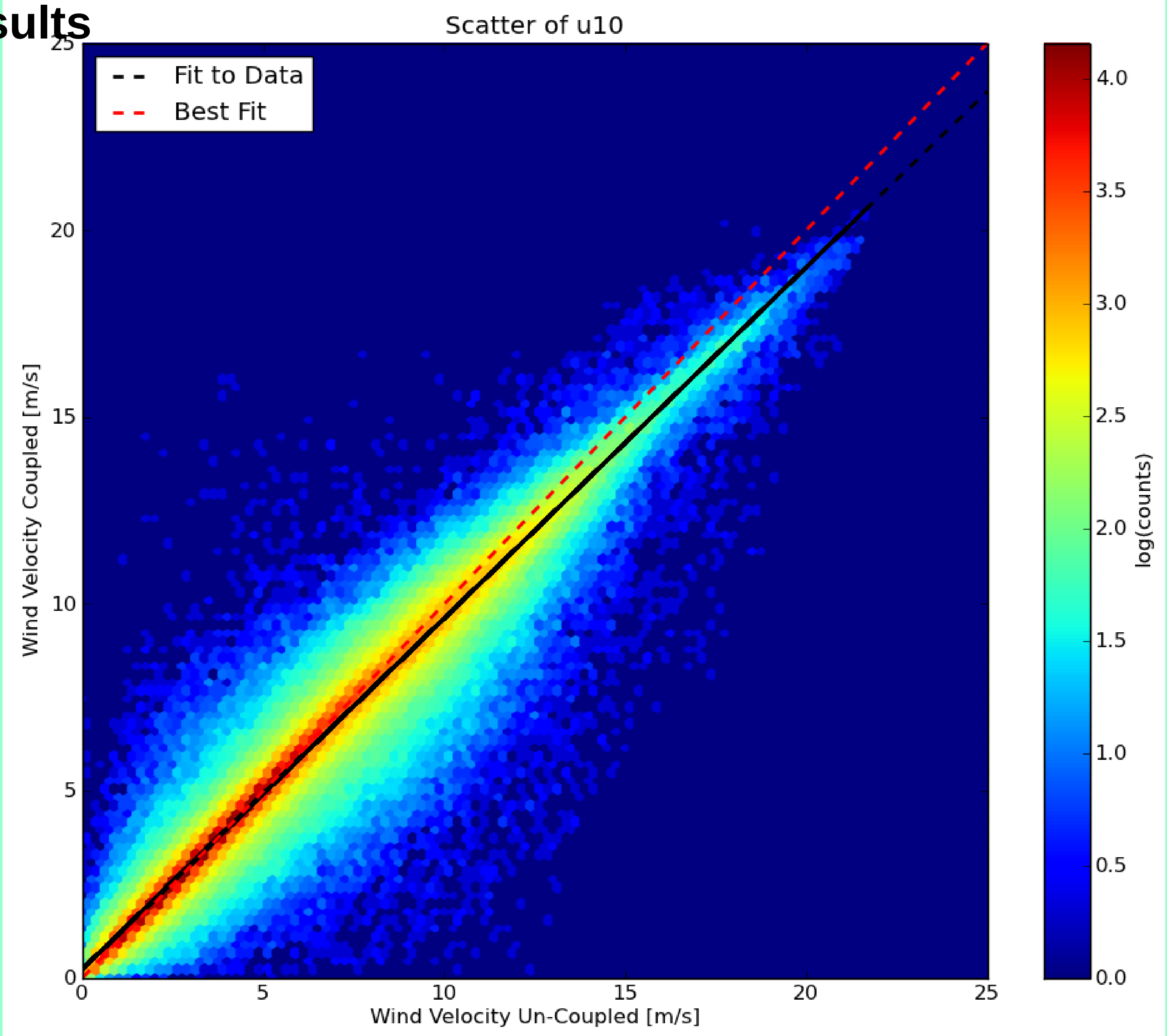
This was achieved by some suitably designed functions

The approach makes the overall procedure quite transparent and easy to follow

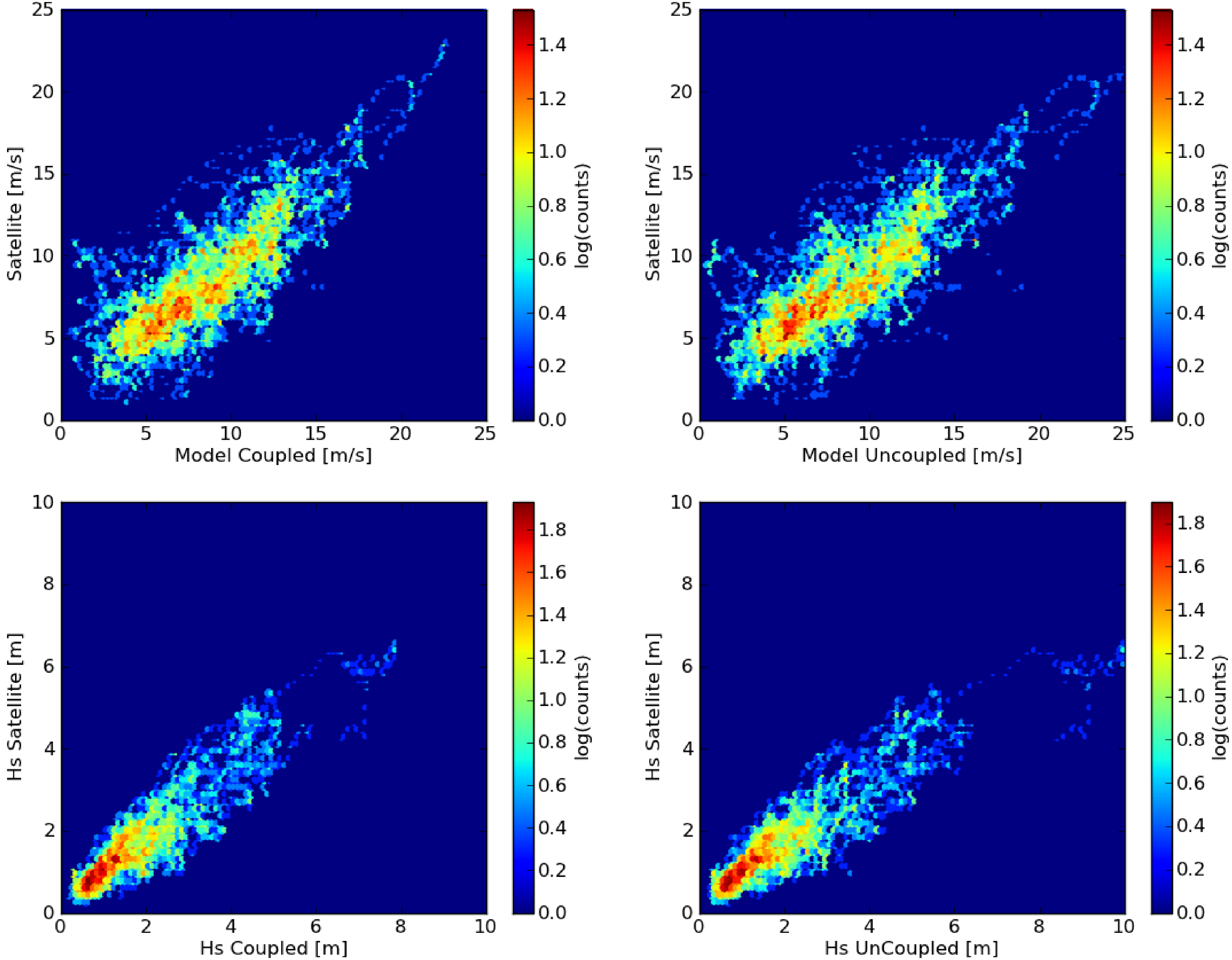
Grids



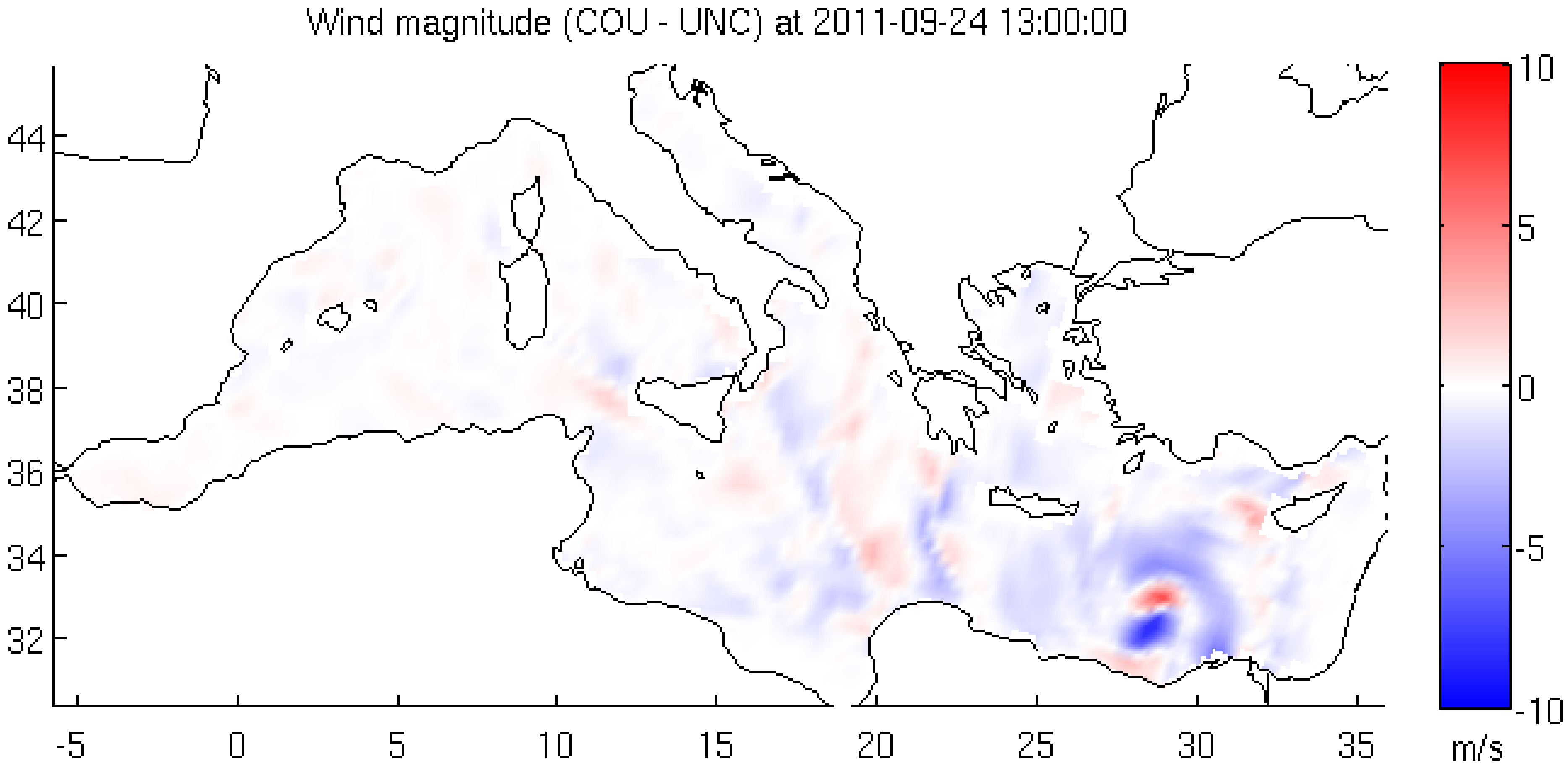
Results

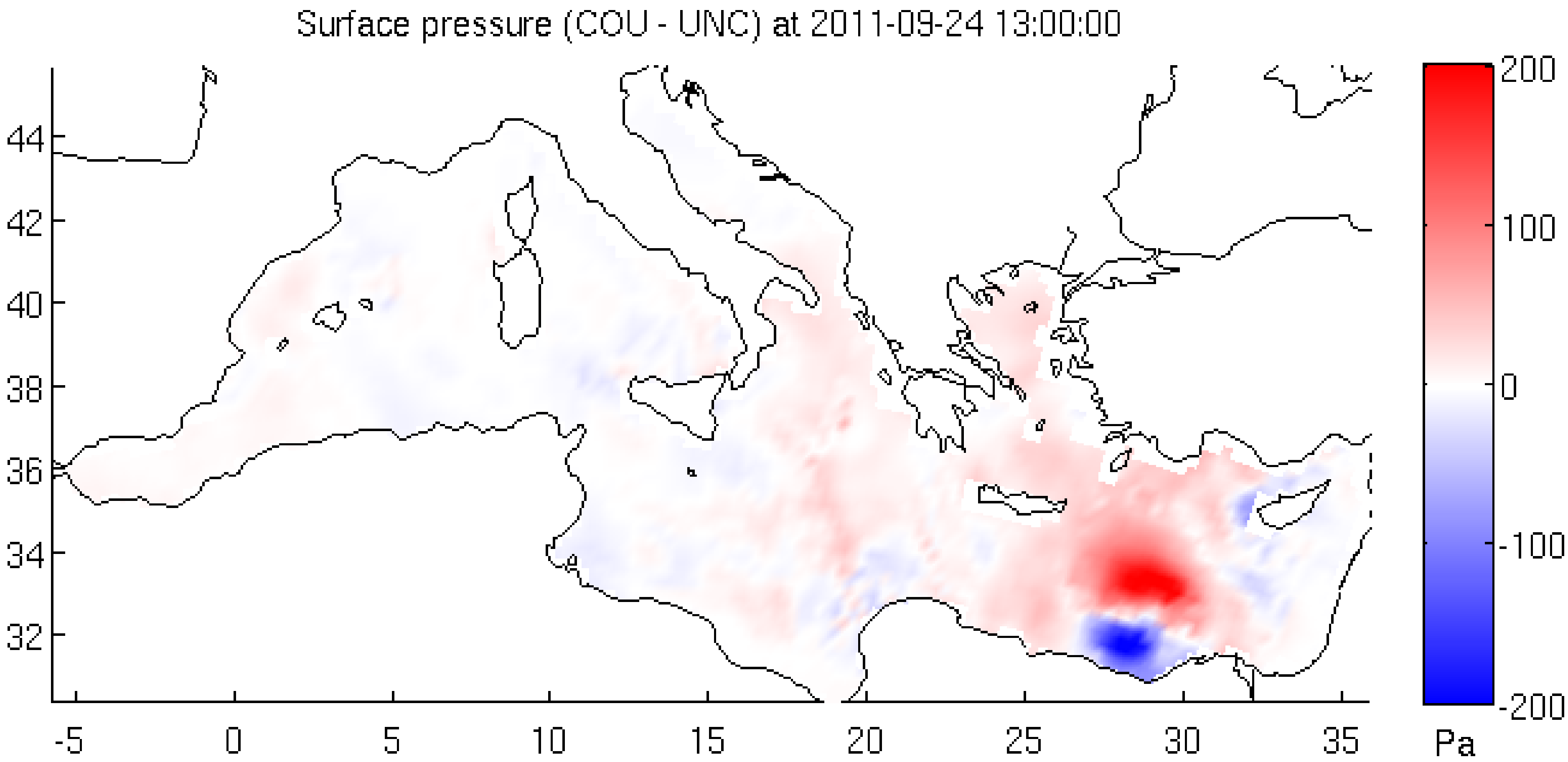


Scatter of u10
Fit to Data
Best Fit
Wind Velocity Coupled [m/s]
Wind Velocity Un-Coupled [m/s]
0
5
10
15
20
25
log(counts)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

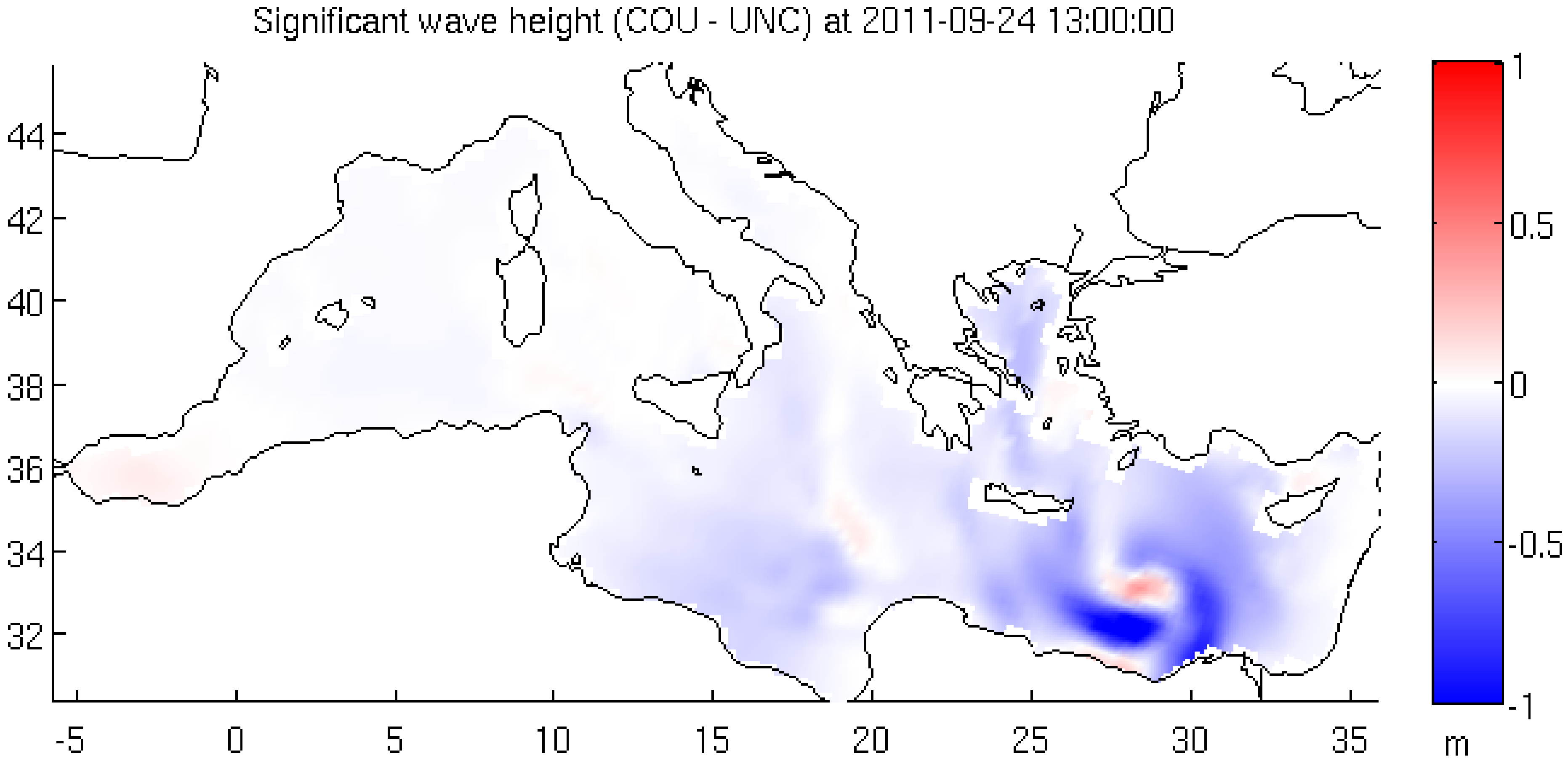


Satellite [m/s]
Model Coupled [m/s]
log(counts)
Satellite [m/s]
Model Uncoupled [m/s]
log(counts)
Hs Satellite [m]
Hs Coupled [m]
log(counts)
Hs Satellite [m]
Hs UnCoupled [m]
log(counts)


Wind magnitude (COU - UNC) at 2011-09-24 13:00:00
44
42
40
38
36
34
32
-5
0
5
10
15
20
25
30
35
10
5
0
-5
-10
m/s



Surface pressure (COU - UNC) at 2011-09-24 13:00:00
44
42
40
38
36
34
32
-5
0
5
10
15
20
25
30
35
200
100
0
-100
-200
Pa


Significant wave height (COU - UNC) at 2011-09-24 13:00:00
44
42
40
38
36
34
32
-5
0
5
10
15
20
25
30
35
1
0.5
0
-0.5
-1
m

Results

		ME	AE	RMSE	CRMSE	Corr	sci	sciR
Waves	Coup	0.13	0.39	0.54	0.52	0.90	0.31	0.30
	Uncoup	0.29	0.47	0.71	0.65	0.90	0.42	0.38

		ME	AE	RMSE	CRMSE	Corr	sci	sciR
Wind	Coup	0.09	1.59	2.12	2.12	0.81	0.25	0.25
	Uncoup	0.23	1.71	2.25	2.24	0.82	0.27	0.26

	Wave			Wind			
Period	ME	AE	RMSE	ME	AE	RMSE	
11/11/2010	-0.16	0.27	0.31	-0.33	1.03	1.30	NbPt=1119
11/21/2010	-0.01	0.20	0.27	-0.29	1.43	1.86	NbPt=1291
12/1/2010	0.04	0.28	0.37	0.19	1.33	1.72	NbPt=1402
12/11/2010	0.03	0.31	0.42	-0.07	1.23	1.70	NbPt=1453
12/21/2010	0.24	0.53	0.67	-0.39	2.27	2.95	NbPt=1480
12/31/2010	0.65	0.74	0.89	1.53	2.18	2.61	NbPt=1248

	Wave			Wind		
Period	ME	AE	RMSE	ME	AE	RMSE
11/11/2010	-0.01	0.26	0.33	-0.08	1.03	1.32
11/21/2010	0.07	0.23	0.34	-0.24	1.36	1.77
12/1/2010	0.10	0.28	0.38	0.24	1.35	1.73
12/11/2010	0.16	0.37	0.55	0.02	1.43	1.91
12/21/2010	0.51	0.70	0.90	-0.25	2.49	3.13
12/31/2010	0.90	0.97	1.26	1.77	2.47	2.89

Two month comparison vs Jason altimeter

Overall results:

passing from uncoupled to coupled models:

U_{10}	**bias reduced of 48%**
	scatter index reduced of 5%
H_s	**bias reduced of 50%**
	scatter index reduced of 20%

(this still with a coarse resolution, 0.25^{o} –
expected operational resolutions atm 7 km
wave 0.05^{o})