Laboratori d'Enginyeria Marítima
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Multi-scale coupled modelling along the Catalan coast.

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SEVENTH FRAMEWORK PROGRAMME

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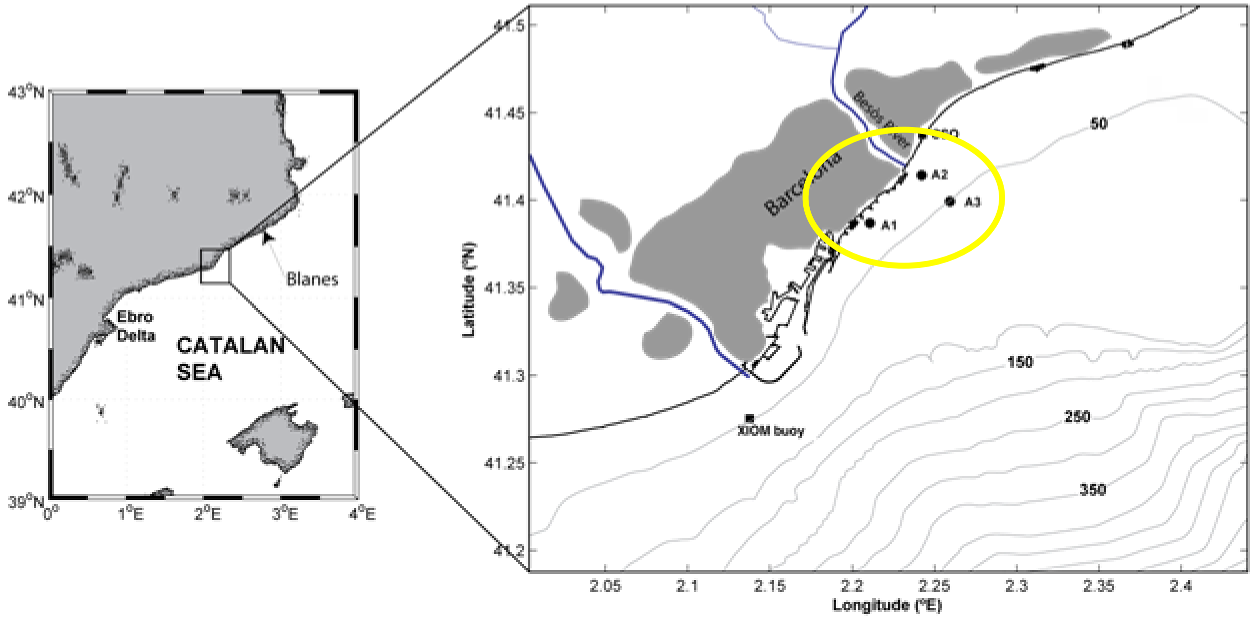
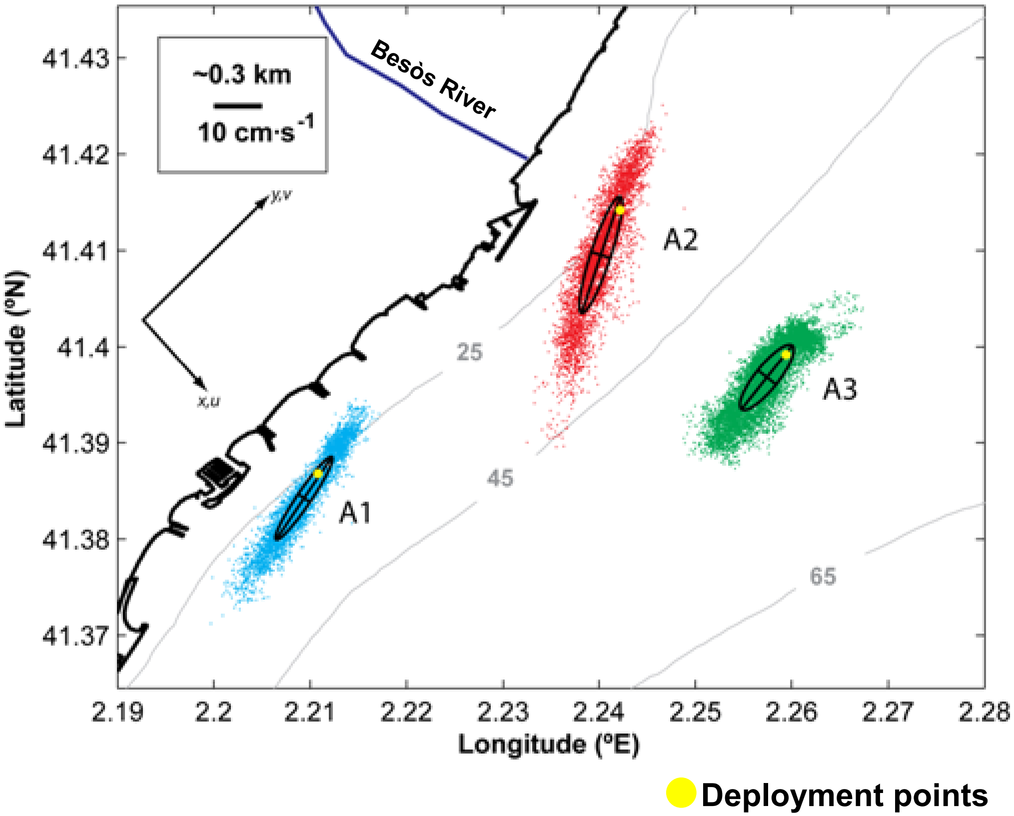
1. INTRODUCTION.

Dynamics in the Catalan inner-shelf from observations



- **Micro-tidal environment and mild winds, presence of small river ("flash-flood").**
- **Shelf break ~ 150 m depth. Shelf width ~ 10 km**
- **R_I ~ 10 Km , R_E ~ 100 Km , d_{ekman} ~ 25 m**
- **Data collected in 3 ADCPs (25 and 50 m) during May-April 2011.**

Dynamics in the Catalan inner-shelf from observations



- Current strong **polarized** in along-shelf direction following the isobaths. Variance accounted by the principal axis (along-shelf) are ~90%.

- Flow in the inner-shelf controlled by **wind** in a local scale and **pressure gradient** in a remote scale.

- Vertical shear is important. Strong thermal stratification during spring and summer (N~0.04 s^{-1})

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Numerical Tools:

- **3D CIRCULATION MODEL: ROMS**
- **WAVE MODEL: SWAN**
- **COUPLING TOOL SWAN-ROMS (“on-line”): MCT (Model Coupling Toolkit; Jacob et al., 2005).**
- **WAVE-CURRENT INTERACTION: VORTEX FORCE (Kumar et al., 2012).**
- **REFINEMENT (nesting two-ways): COAWST (Warner et al., 2010).**
- **Parallel Computer System: MPI.**

⬇

Tests to evaluate the influence of the refinement, wave-current interaction,…?

2. METHODS.

Circulation model domains

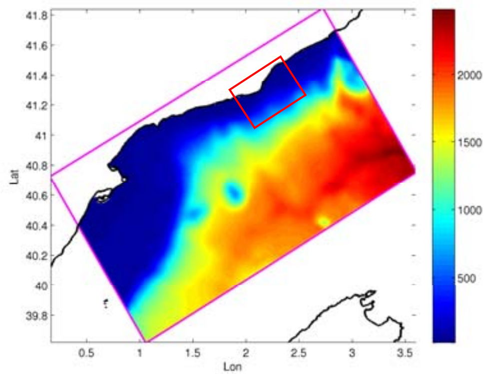
MyOcean v.1
(dx~6.5 km)

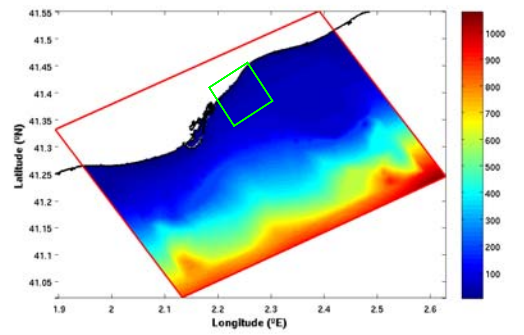
myOcean

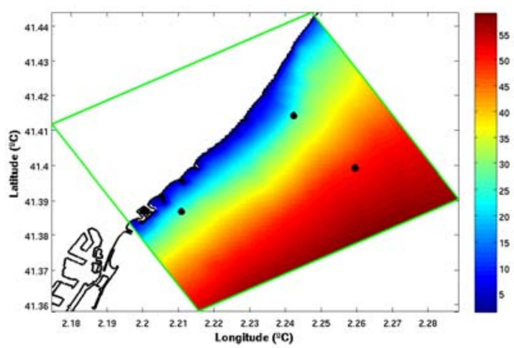
SHECAT model (dx~1km)

Coastal model (dx~250 m)

Local model (dx~40 m).







See: ADCP locations

Atmospheric forcing:

+ observations

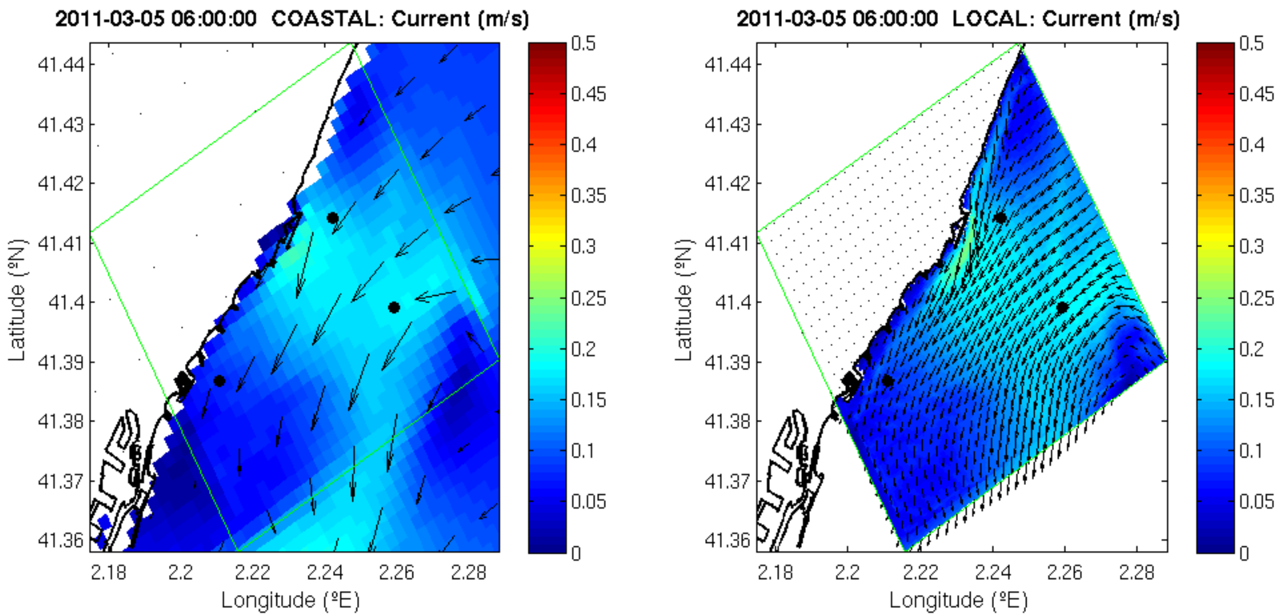
BSC

Wave model domains

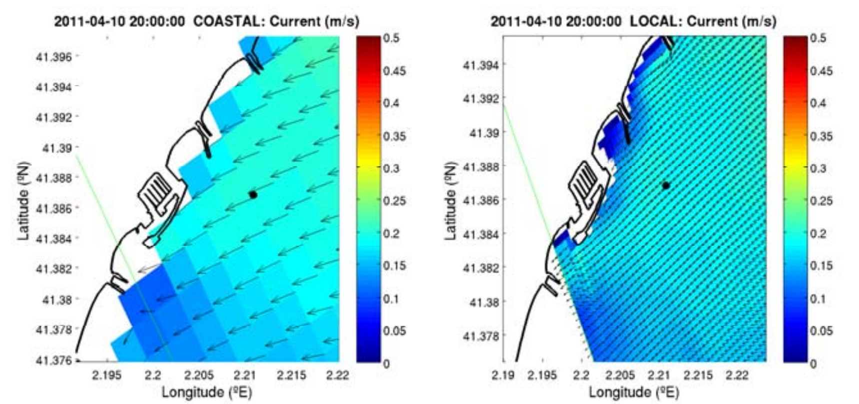
9x9 km
⬇
3x3 km
⬇
1x1km (SHECAT)
⬇
250x250 m (COASTAL)
⬇
40x40 m (LOCAL)

➡ **Different wind sources: ECMWF, BSC., etc.**

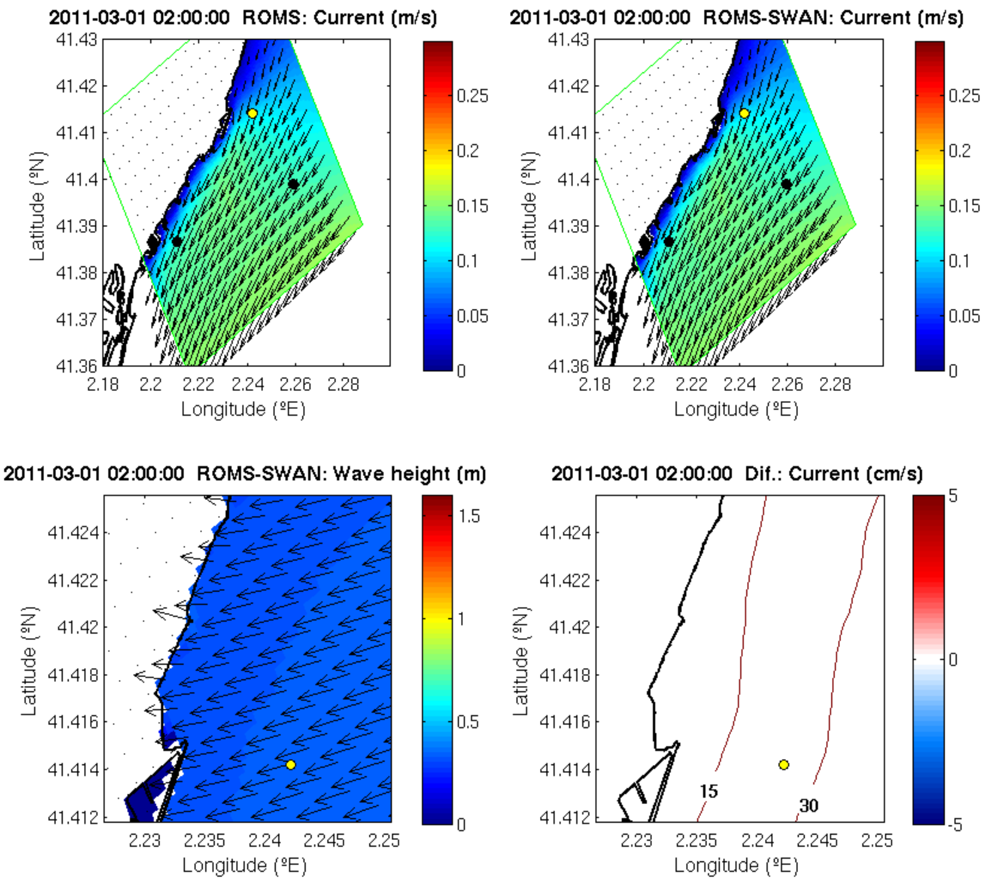
Example refinement simulations: 2 models COASTAL+LOCAL (“two-ways))



Details…



Example Wave Effect in Current: 4 models “two-ways and coupled” COASTAL+LOCAL and SWAN+ROMS



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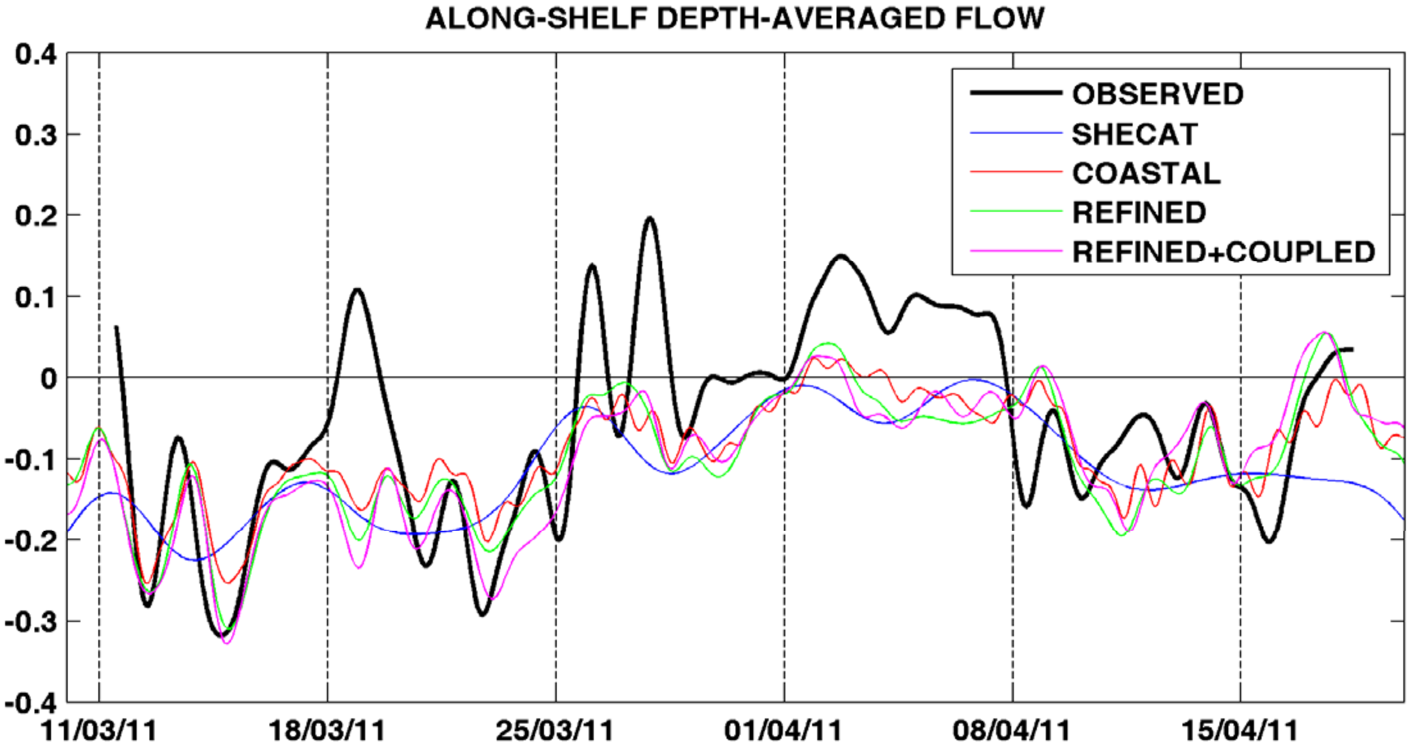
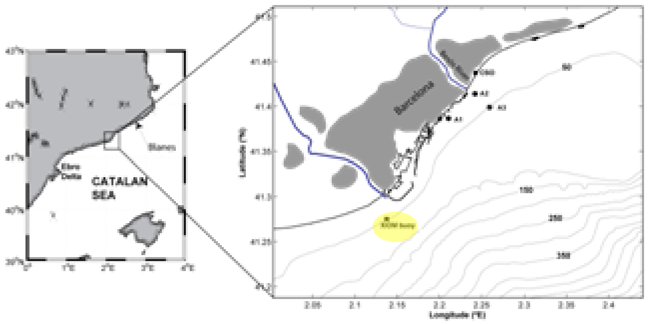
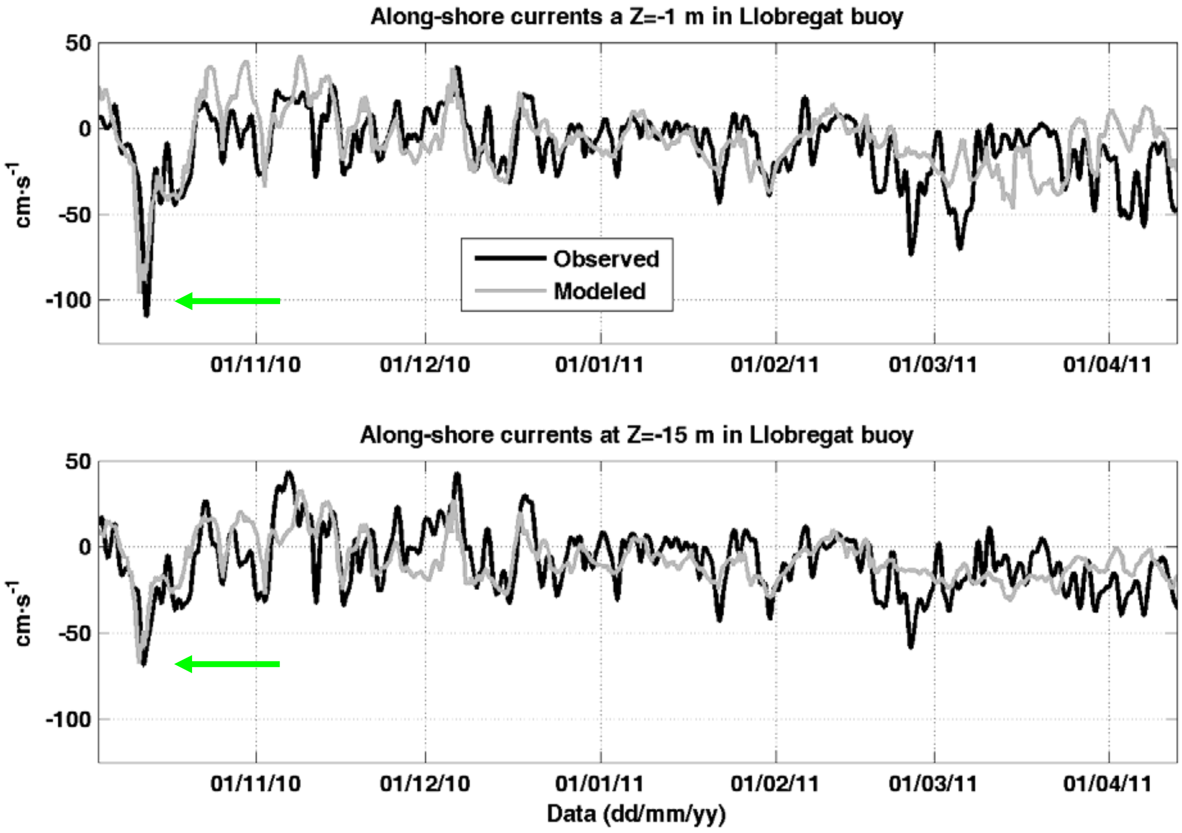
Simulations comparison. Depth-averaged velocities in A1 at z=-25 m.



Comparison during an energetic event (COASTAL model).

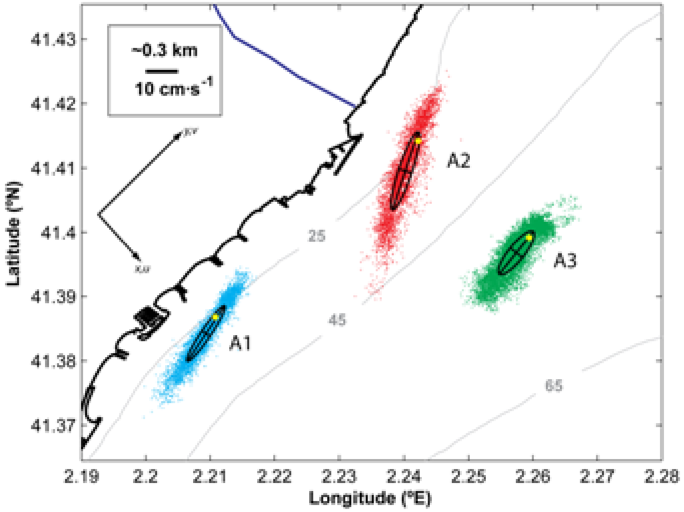


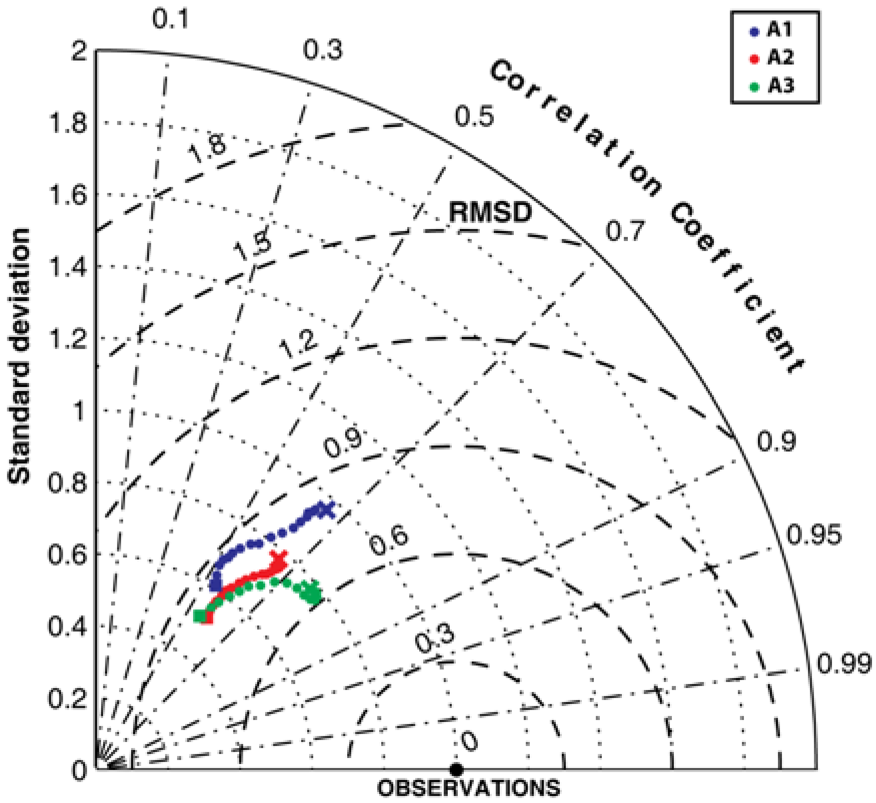


Storm during October 2010

3. RESULTS.

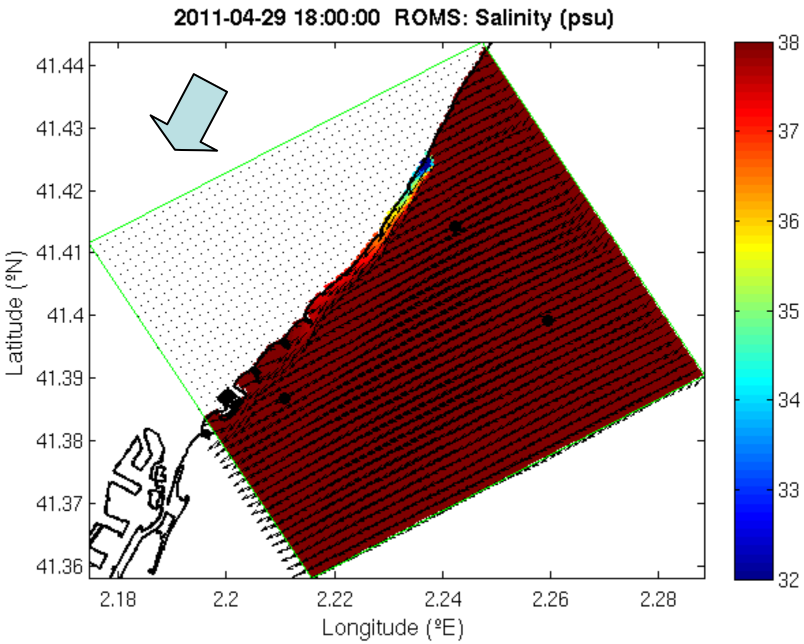
Comparison during the intensive field campaign. Normalized Taylor diagram.



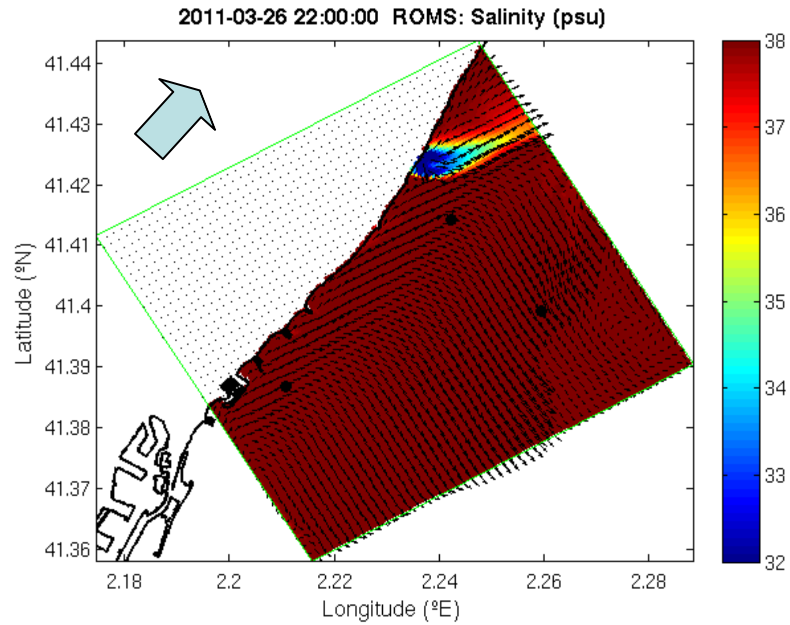


Surface (x) is better represented by the model than bottom layers (■).

River plume dynamics



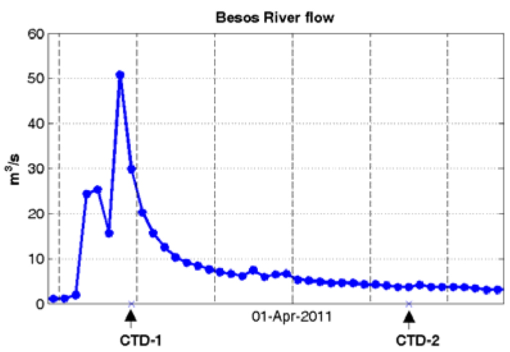
North-east winds

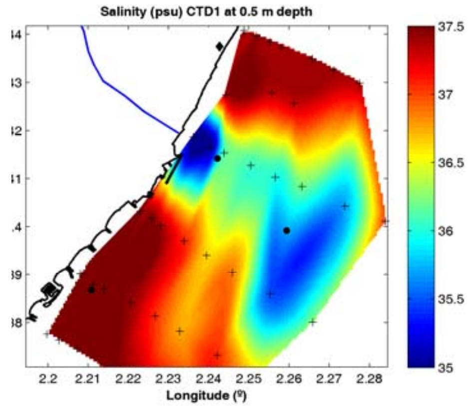


South-west winds

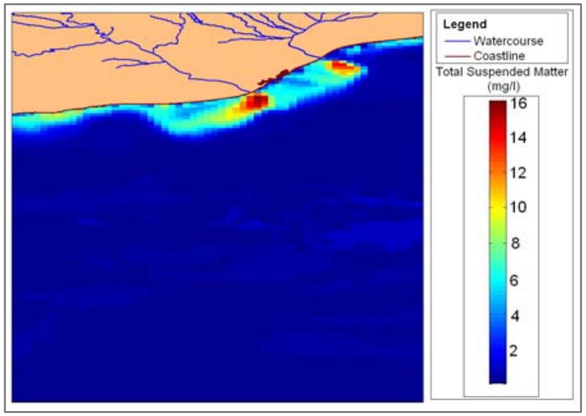
River plume dynamics

Storm ("flash-flood event")

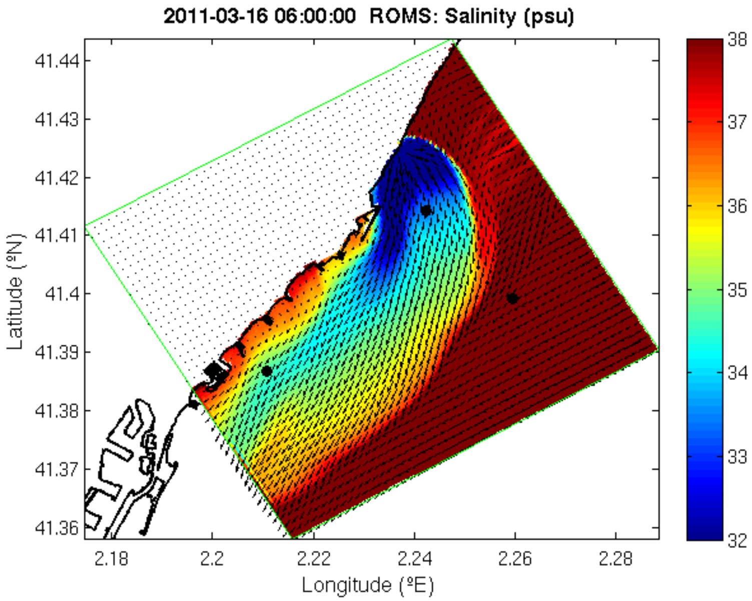




CTD (17-3-2011)

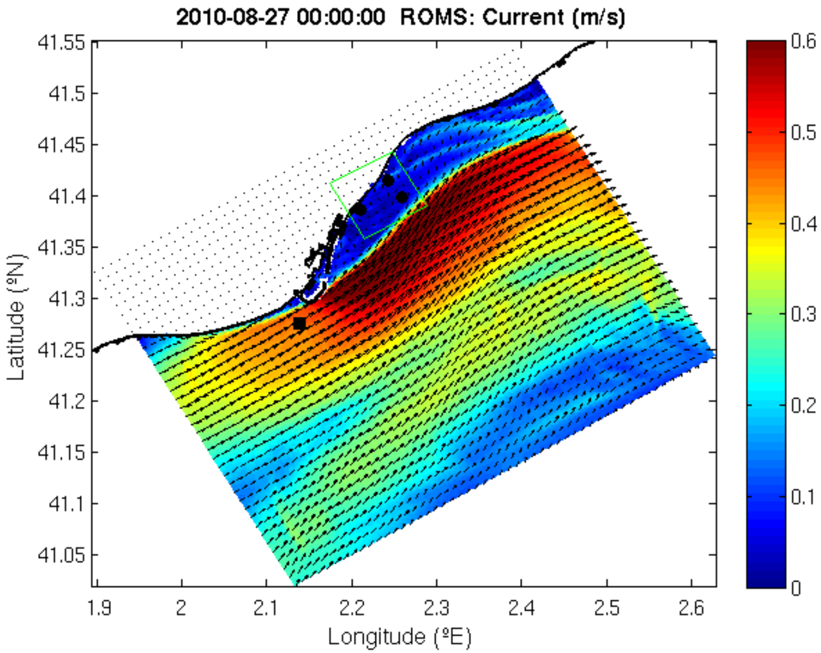


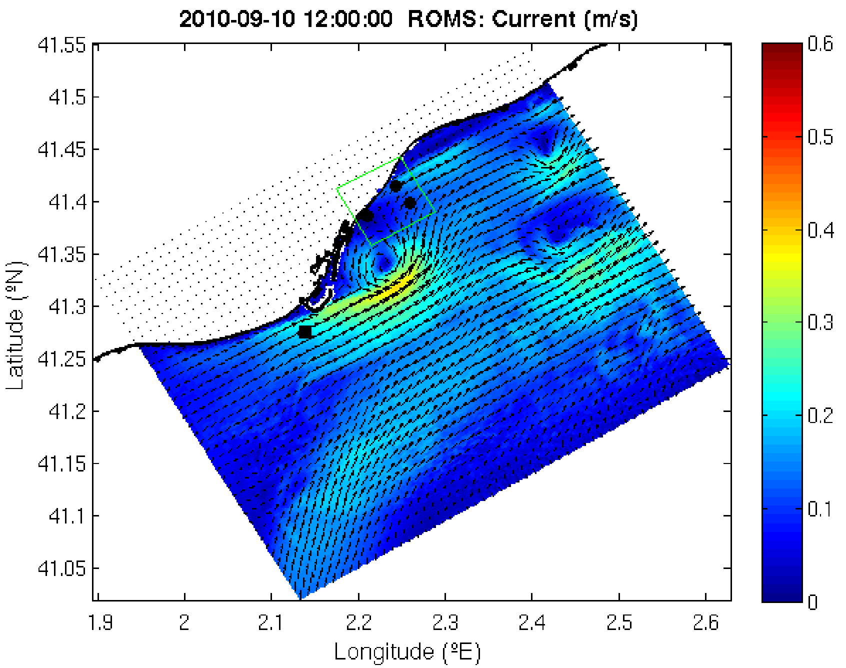
MERIS satellite images (13-3-2011)



3. RESULTS.

Topographic effects in the flow ("unusual"):

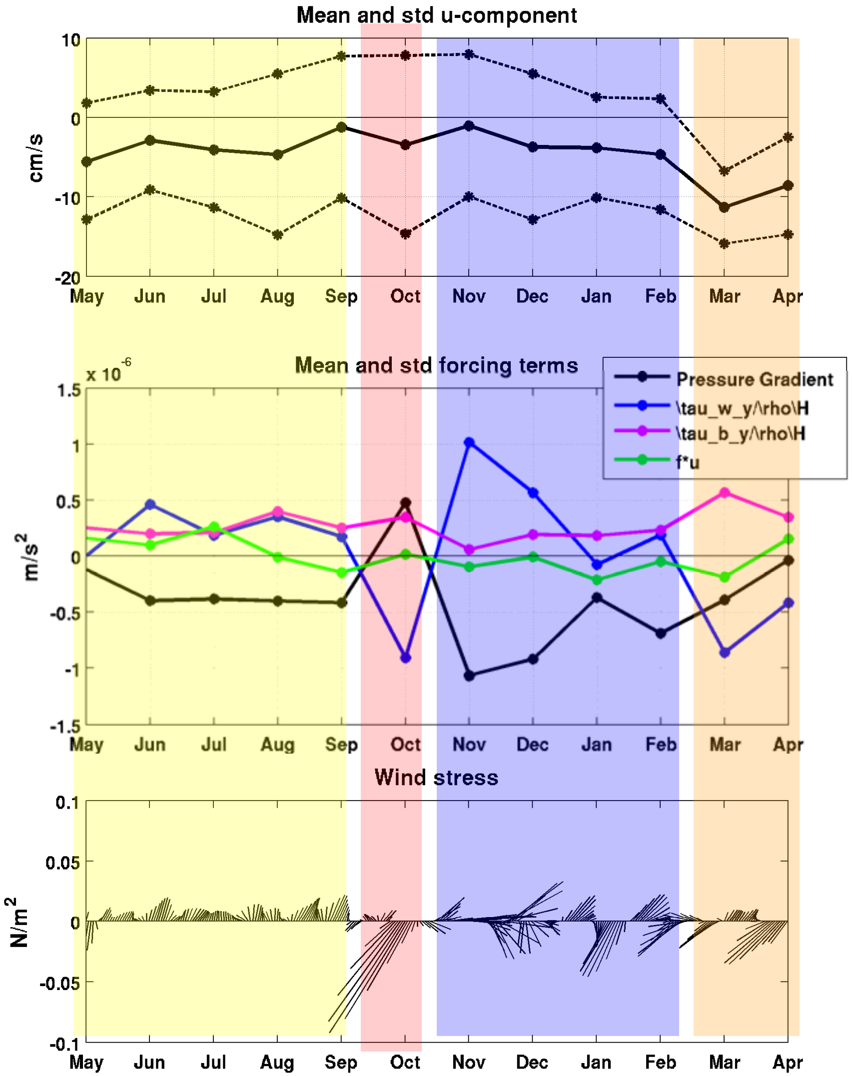




3. RESULTS.

Seasonal chracteriaztion in the inner-shelf.

$$fu = -g\frac{\partial \eta}{\partial y} + \frac{1}{H\rho_0}\left(\tau_{ys} - \tau_{yb}\right)$$



Fall: Transition and unstable months

Predominant shout-westwards flow with significant "reversals" (except May and April)

Summer conditions:

-Flow relatively low driven by pressure gradient.

-South-westerly mild winds.

- Frictional terms counteract pressure gradient term.

Winter conditions:

-Flow relatively low driven by pressure gradient.

-Westerly (land) and along-shelf winds

- Along-shelf winds stress term counteract pressure gradient.

Spring conditions: (Observations)

- Flow relatively high

- North-Easterly winds

- Along-shelf winds acting together with pressure gradient. Bottom stress balance the model

4. SUMMARY.

- A “coupled two-ways” numerical model system has been implemented at Catalan inner-shelf. The model reproduce partially the main flow and the current variability.
- The inner-shelf dynamics is controlled by local wind and remote pressure gradient.
- Wave induced currents are low in the ADCP deployments depths.
- Intra-annual characterization allow to determine seasonal patterns.

Future works:

- Implementation in a high resolution atmospheric model.
- Calibration of Wave Effect on Currents in new observational data set in surf-zone and inner-shelf (below 25 m depth).

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