

DEMO WORKSHOP BRAINPORT 2020

AUTORIDAD PORTUARIA BAHÍA DE ALGECIRAS

19 de Octubre de 2016

MODELO HIDRODINÁMICO DE ALTA RESOLUCIÓN EN EL PUERTO DE LA BAHÍA DE ALGECIRAS

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An aerial photograph of the Bay of Algeciras, showing the city of Algeciras on the right, the bay in the center, and the surrounding mountains and coastline on the left. The word "CONTENTS" is overlaid in white text on the blue water.

CONTENTS

- **Hydrodynamic model and its sub-domains**

- **Nesting**

- **Validation**

- **Water quality assessment**

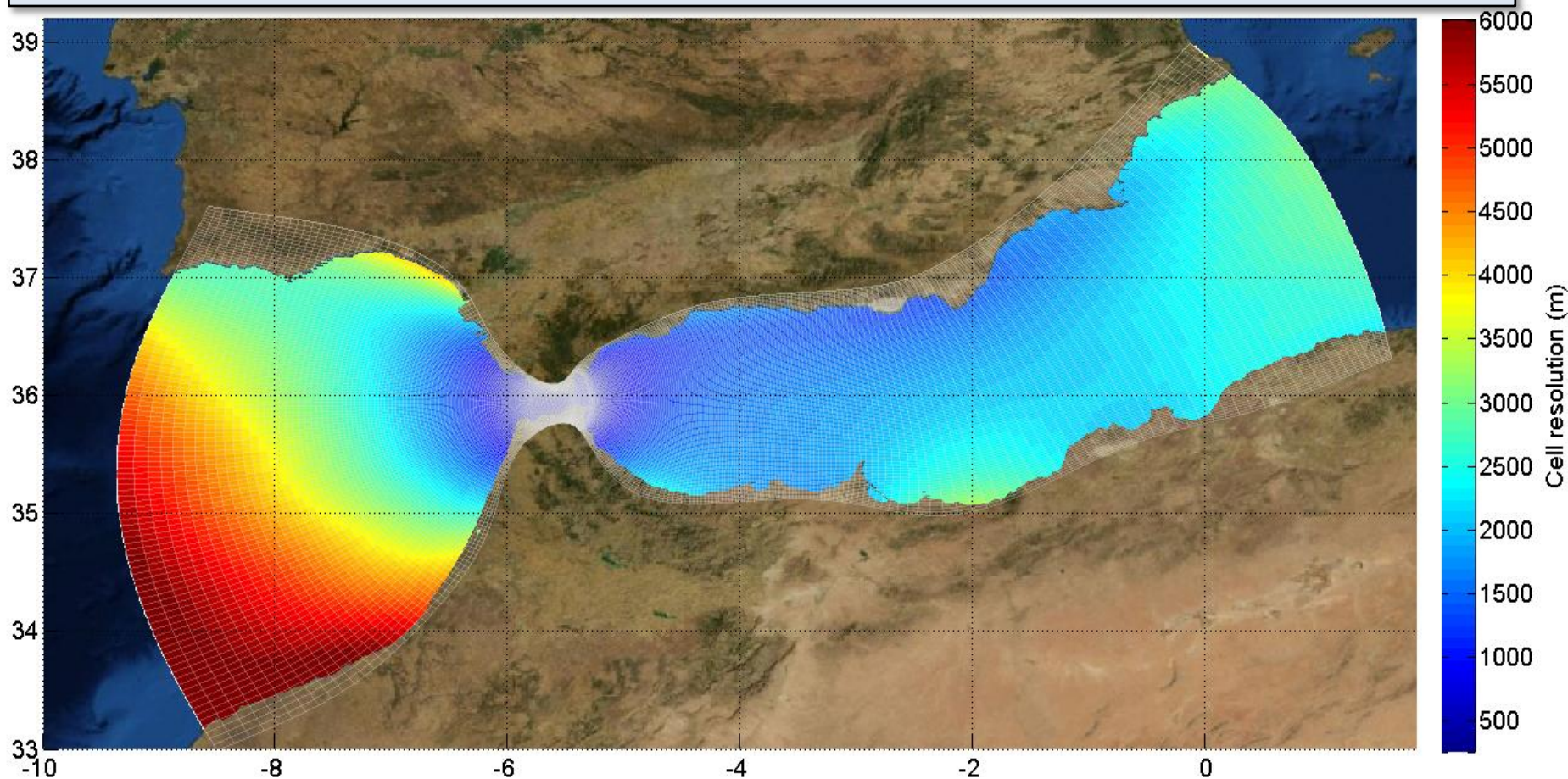
- **Passive tracers**

- **Particle tracking**

REGIONAL DOMAIN GOFIMA-SAMPA

GOFIMA-SAMPA: MITgcm (Massachusetts Institute of Technology General Circulation Model)

- Curvilinear grid: 360 x 96
- Vertical levels: 46
- Total nodes: **1.589.760** nodes
- Horiz. Resolution (Strait of Gibraltar – Bay of Algeciras): ~ 400m



NESTED DOMAINS: FIRST DOWNSCALING - MIDDLE RESOLUTION

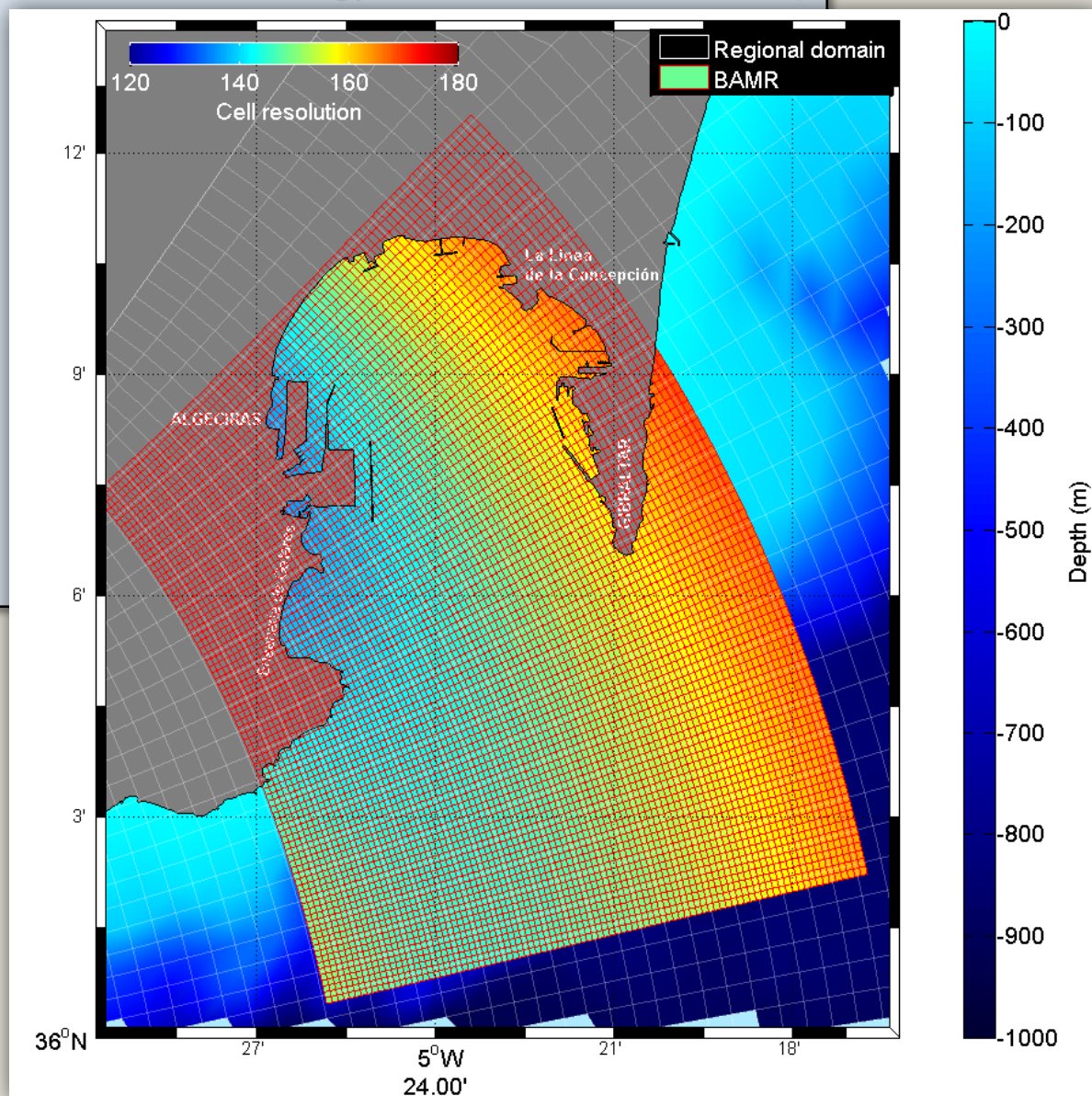
BAMR : MITgcm (Massachusetts Institute of Technology General Circulation Model)

- **Downscaling:**
1:4
- **Curvilinear grid:**
95 x 88 cells
- **Vertical levels:**
35
- **Total nodes:**
292.600 nodes
- **Horiz. resolution:**
120-150 m

GOFIMA-SAMPA



BAMR



NESTED DOMAINS : SECOND DOWNSCALING - HIGH RESOLUTION

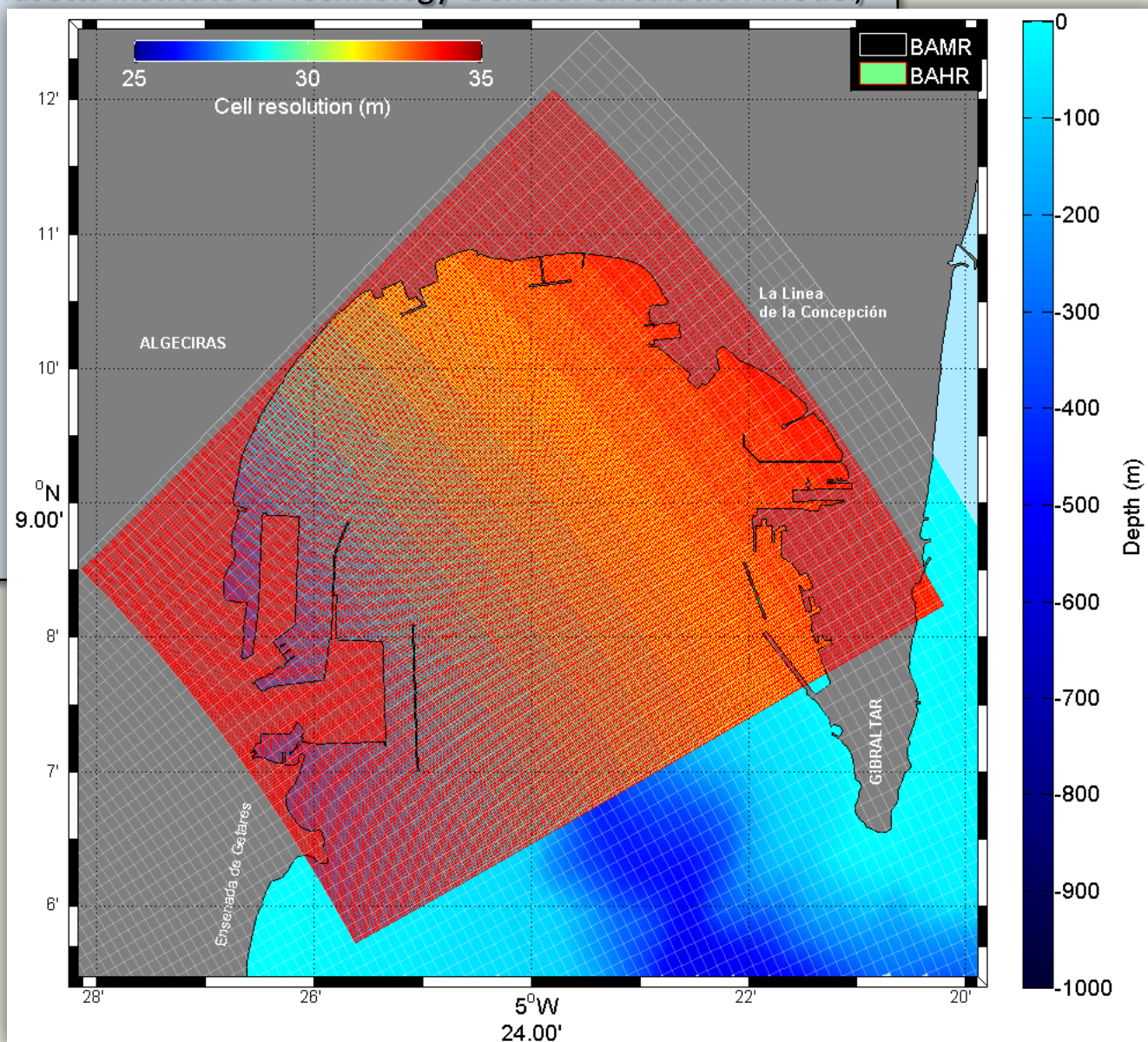
BAHR : MITgcm (Massachusetts Institute of Technology General Circulation Model)

- **Downscaling :**
1:5
- **Curvilinear grid:**
312 x 160 cells
- **Vertical levels:**
35
- **Total nodes:**
1.747.200 nodes
- **Horiz. resolution:**
20-30 m

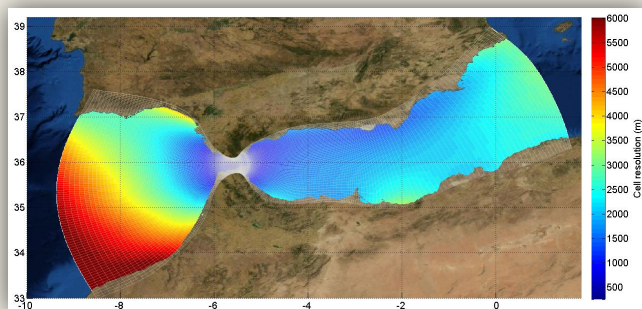
BAMR



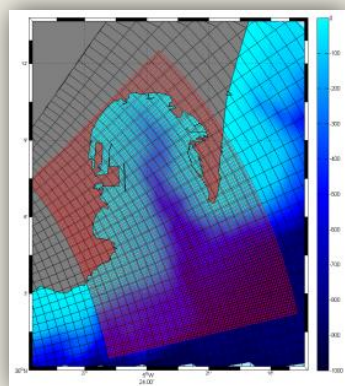
BAHR



NESTING CHAIN



OUTPUTS EVERY 10'



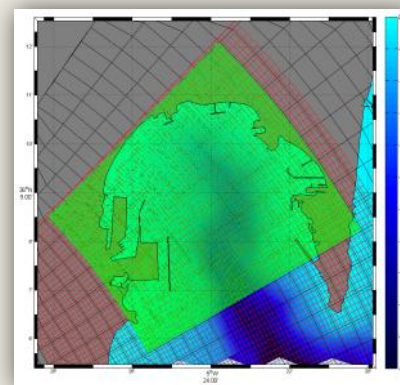
OUTPUTS EVERY 10'

MPI libraries
using 40
processors



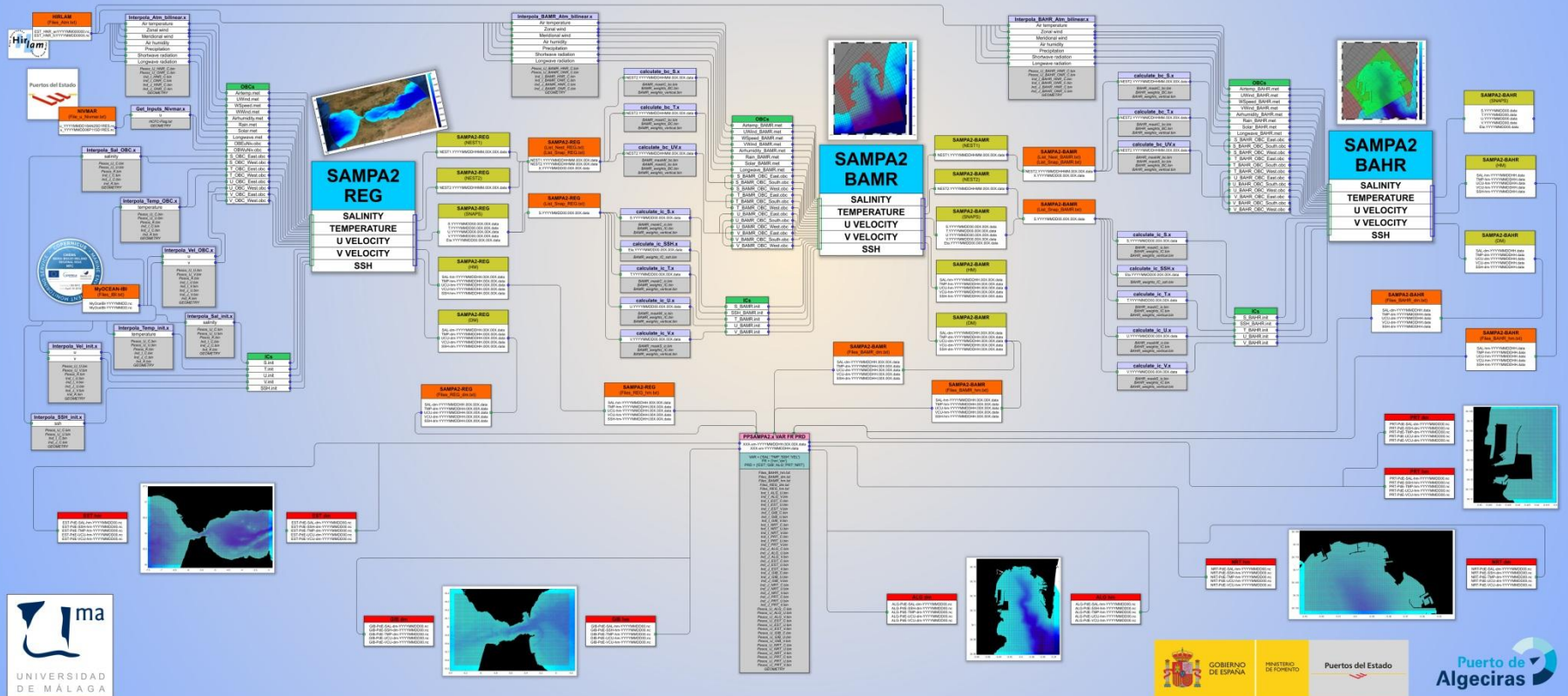
Puertos del Estado

FORECAST IN LESS THEN 2H



SAMPA 2

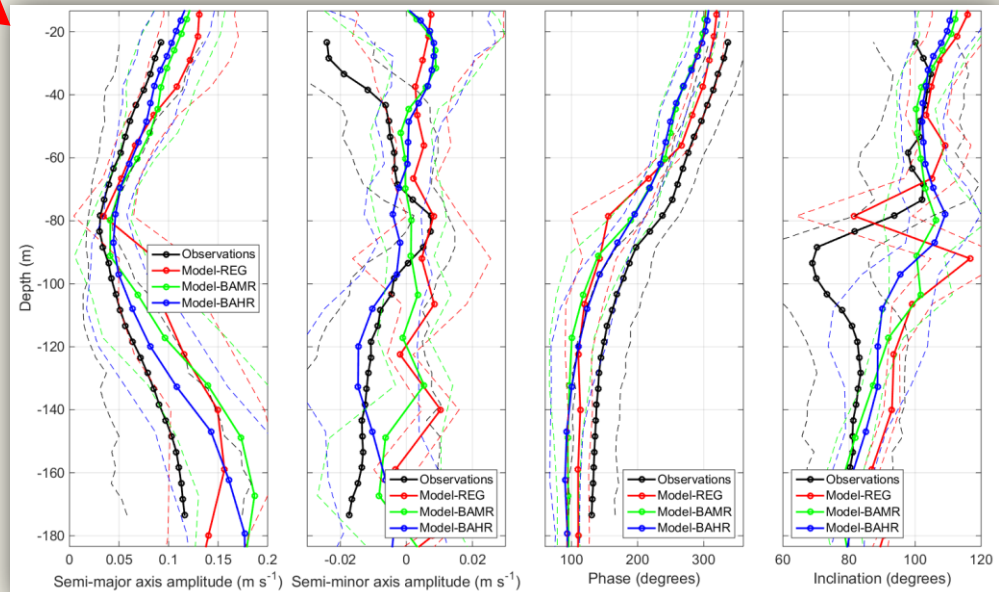
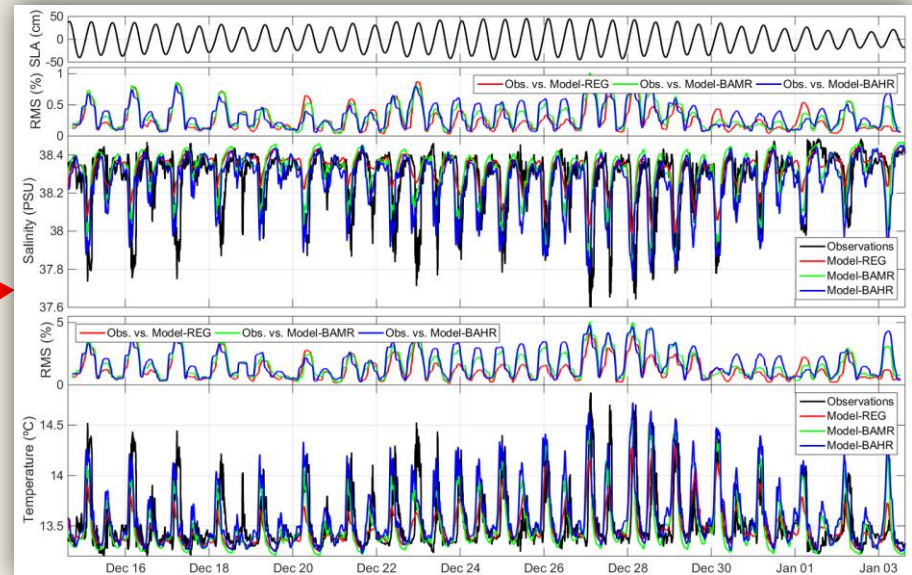
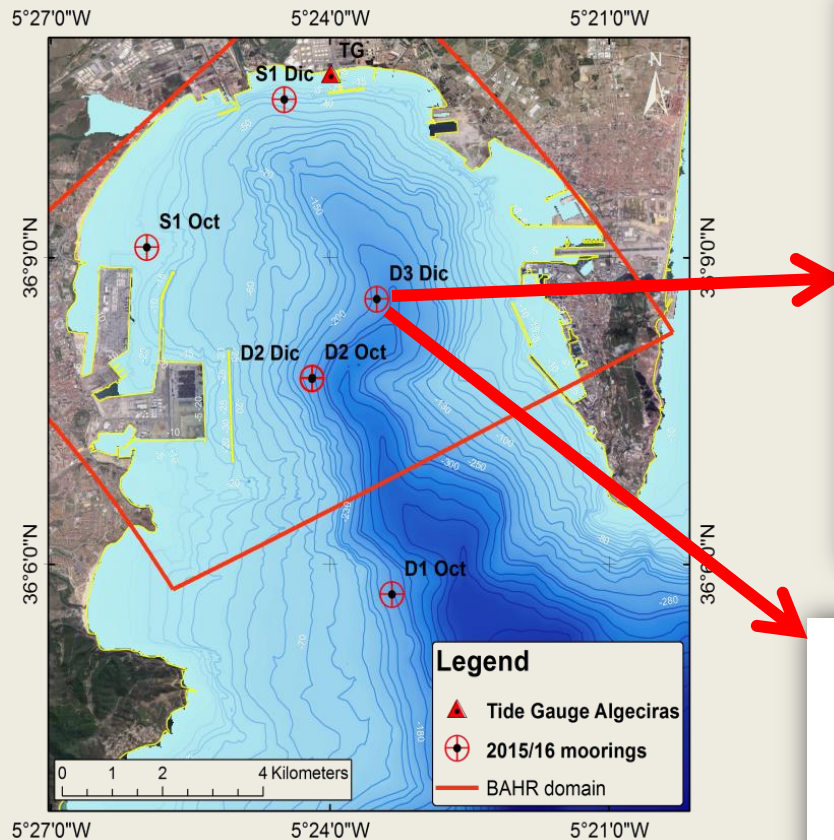
SISTEMA AUTÓNOMO DE MEDICIÓN, PREDICCIÓN Y ALERTA ESQUEMA FUNCIONAL MODO OPERACIONAL





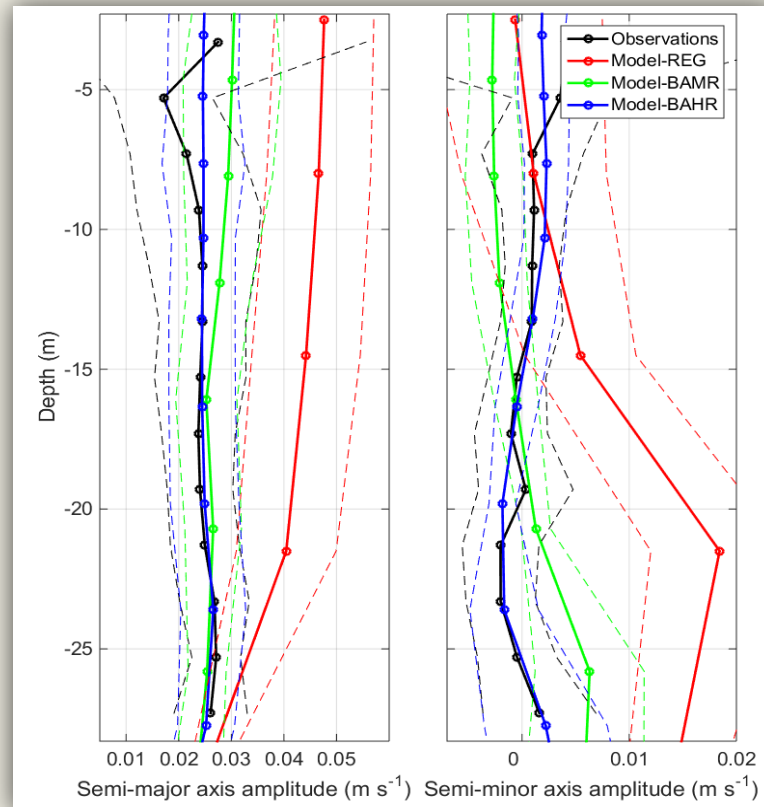
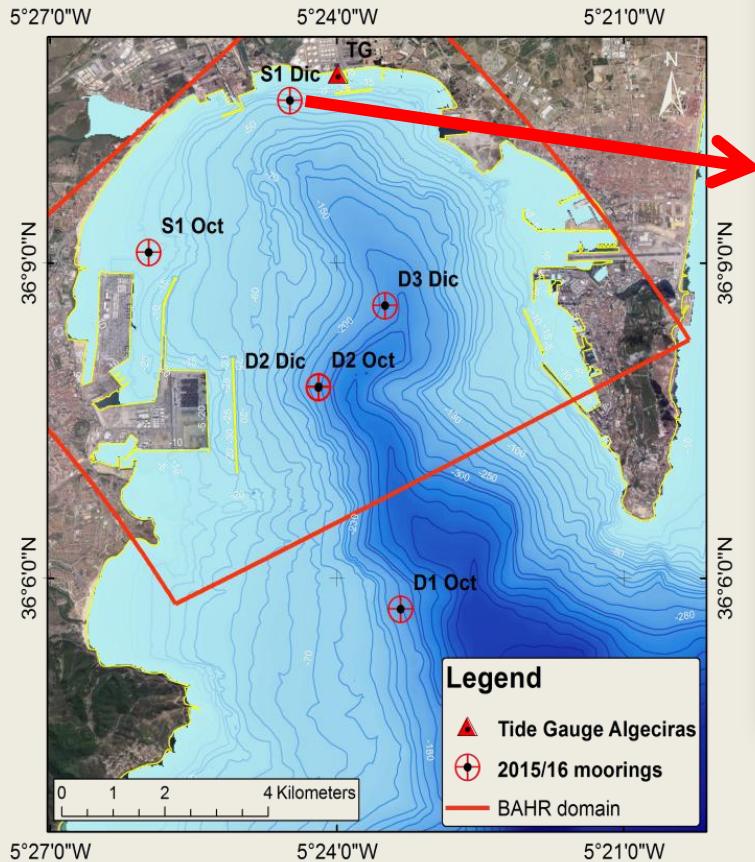
From GOFIMA-SAMPA to BAHR and BAMR: VALIDATION

VALIDATION: CENTER OF THE BAY

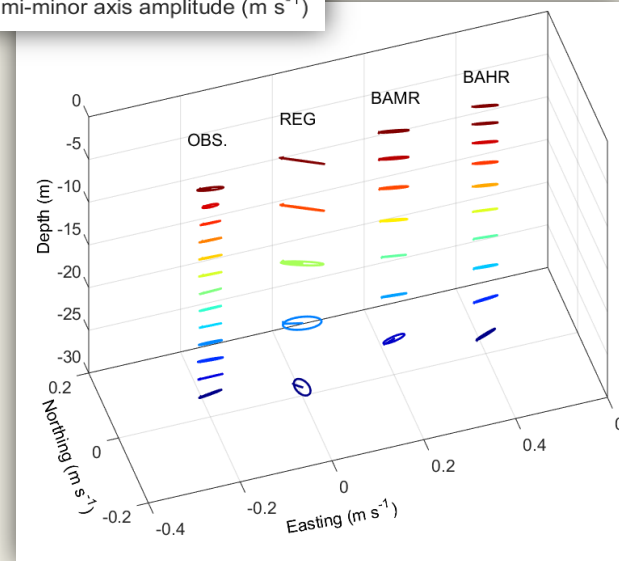


Slight improvement of the solutions in the **deep zone** of the Bay for *BAMR* and *BAHR*

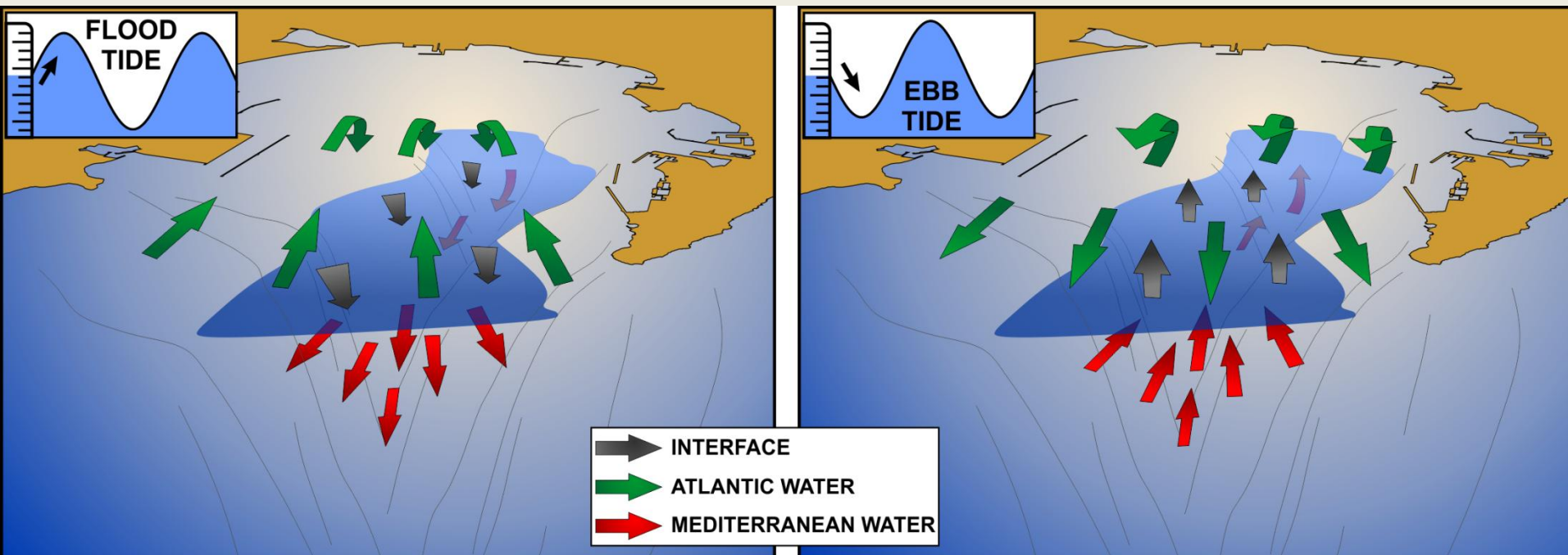
VALIDATION: PORT AREA



Marked improvement of the solutions in shallower areas of the Bay for *BAHR*



BAY OF ALGECIRAS: GENERAL CIRCULATION SCHEME



An aerial photograph of the Bay of Algiers, showing the city of Algiers on the left and the rocky peninsula of the Casbah on the right. The water is a deep blue, and the sky is filled with white clouds. The text "SAMPA2 Hidrodinamic model: WATER QUALITY ASSESSMENT" is overlaid on the bottom of the image.

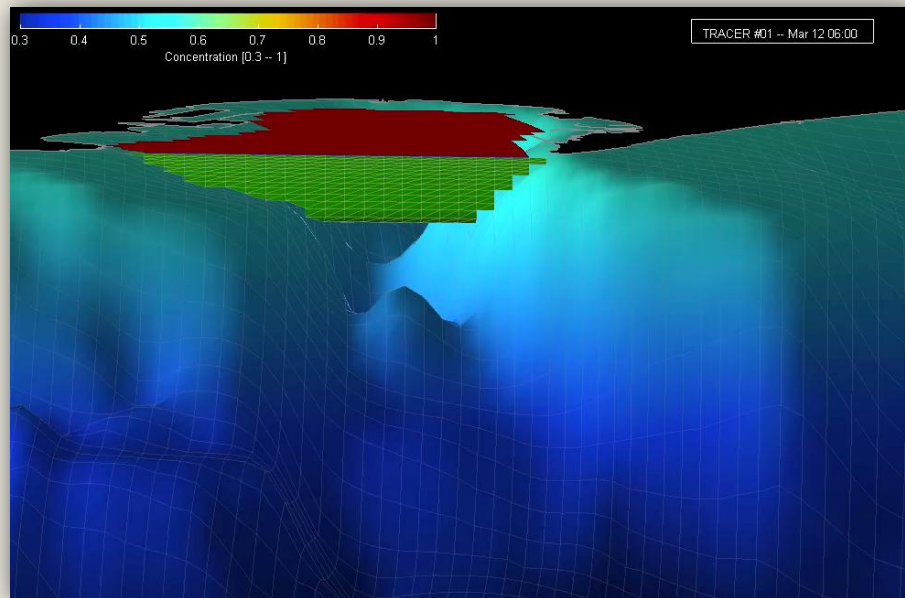
SAMPA2 Hidrodinamic model: WATER QUALITY ASSESSMENT

Demo-Workshop Algeciras BrainPort 2020, 19 de Octubre 2016

WATER QUALITY ASSESSMENT

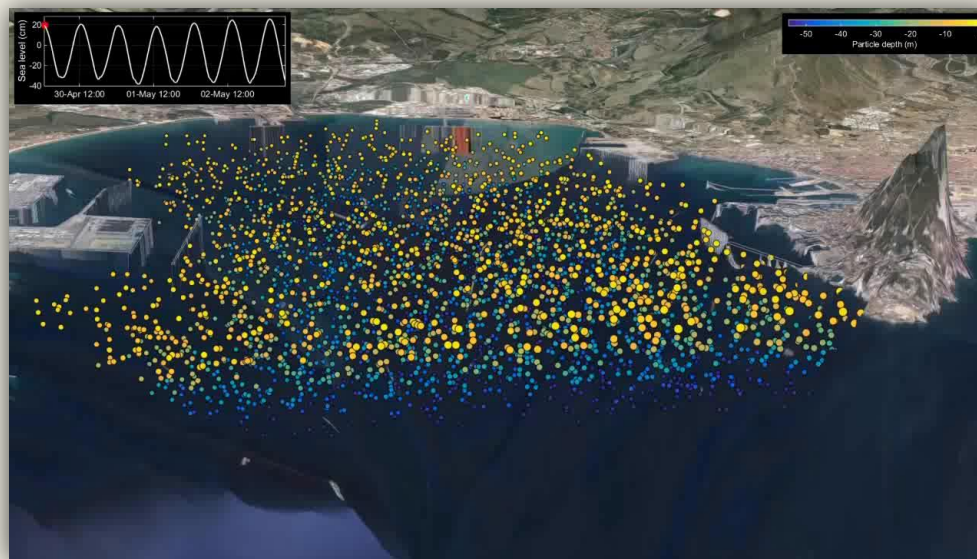
PASSIVE TRACERS

- *Eulerian approach*
- *Online working*
- *TARGET: fill the bay with a pollutant and model its advection/diffusion*



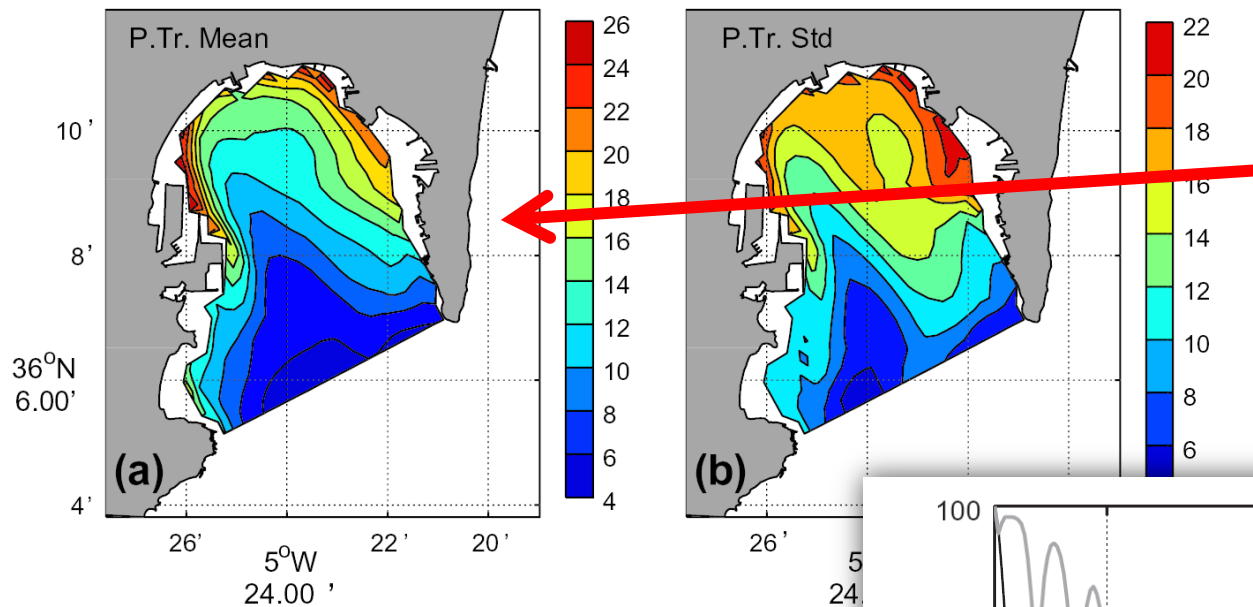
PARTICLES TRACKING

- *Lagrangian approach*
- *Offline working*
- *TARGET: fill the bay with particles and model their advection*



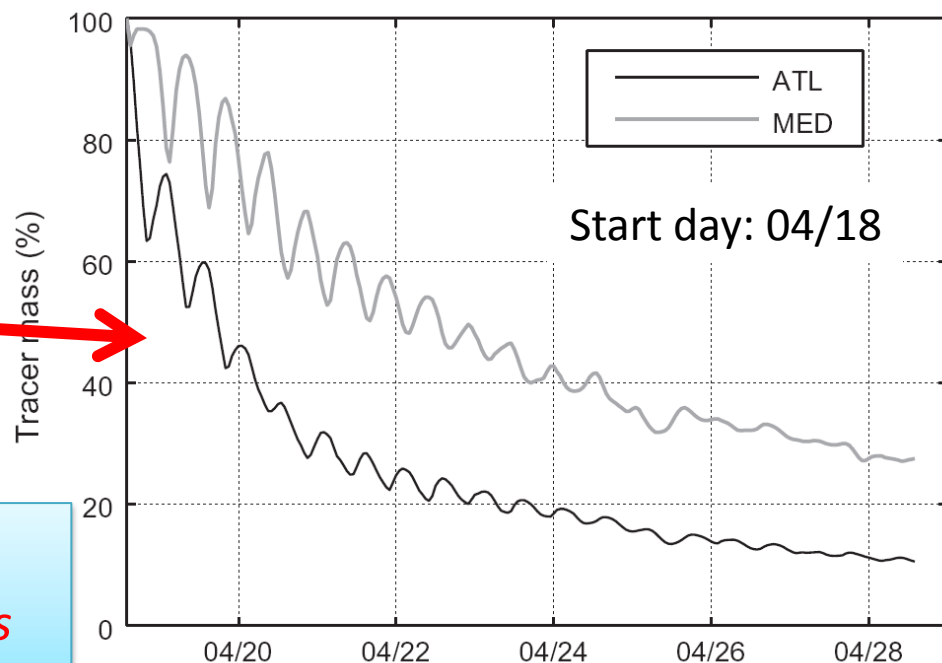
WATER QUALITY ASSESSMENT – PASSIVE TRACER

J.C. Sánchez-Garrido et al. / Marine Pollution Bulletin 80 (2014) 97–106



**Pollutant
percentage
after 7 days
simulation**

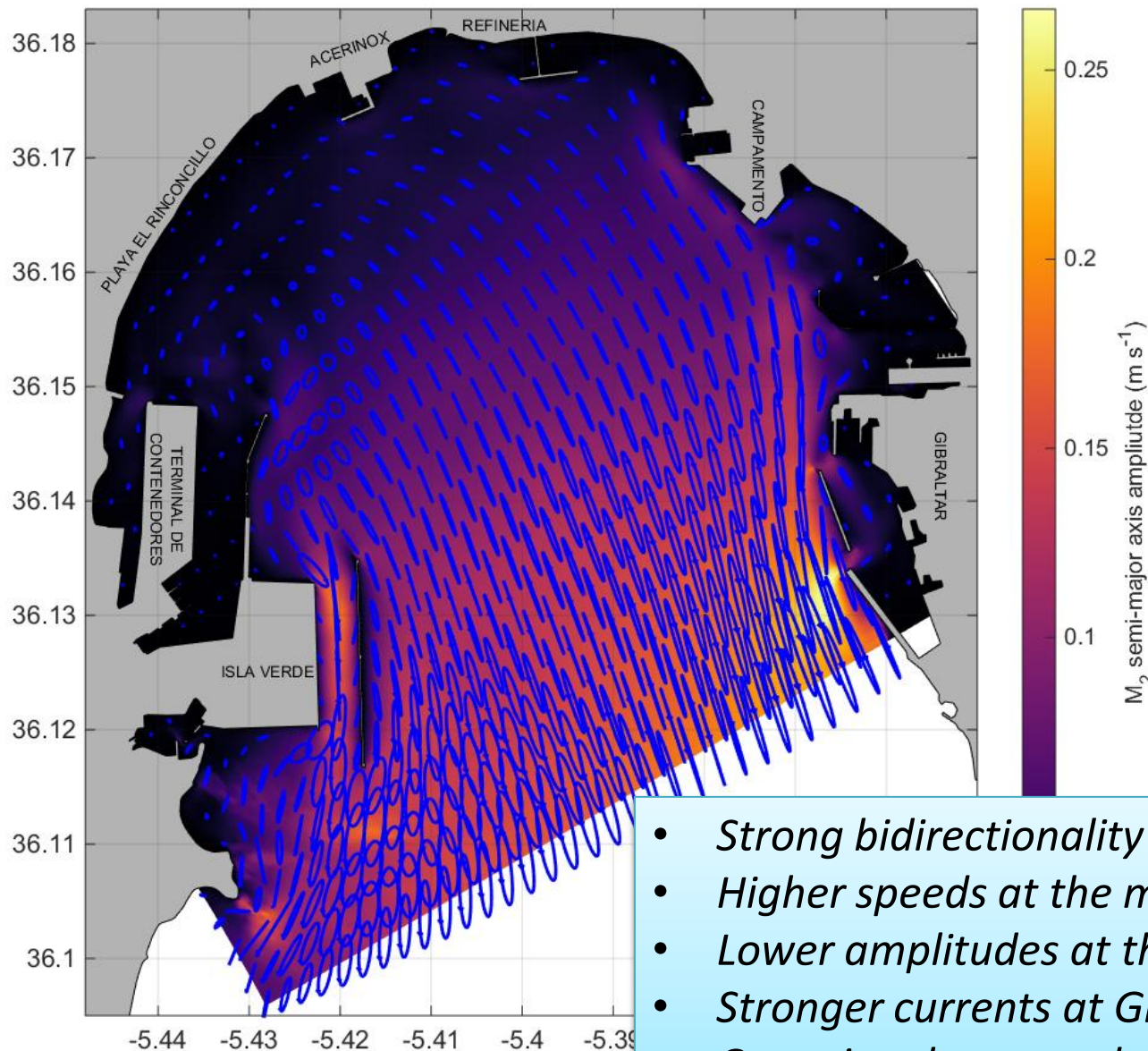
**Water renewal time
of Atlantic and
Mediterranean layer**



SAMPA 1 DOMAIN

Almost no influence of port structures

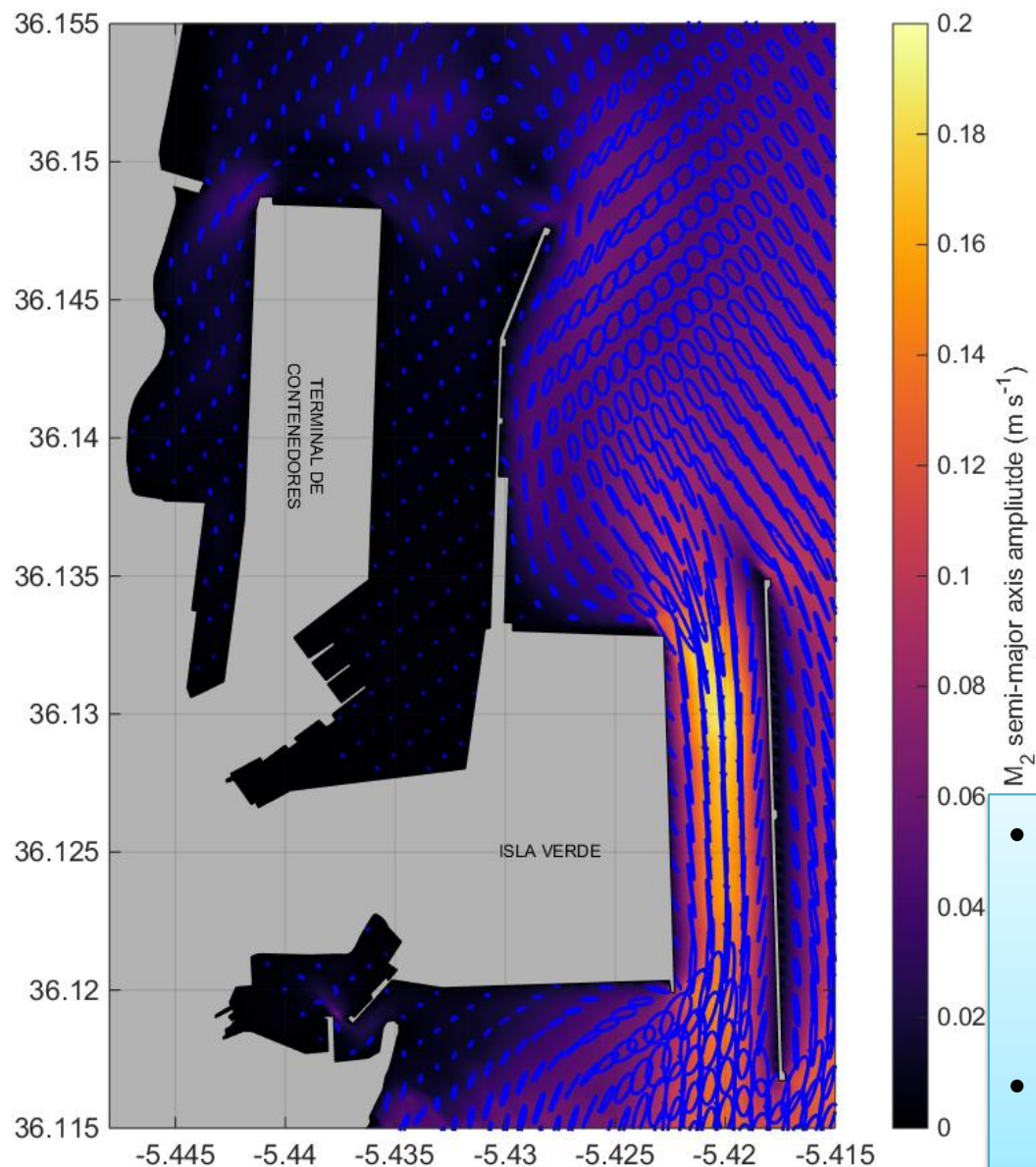
WATER QUALITY ASSESSMENT – HARMONIC ANALYSIS



Whole Bay
One in 8 points!

- *Strong bidirectionality*
- *Higher speeds at the mouth borders*
- *Lower amplitudes at the inner coast*
- *Stronger currents at Gibraltar side (> 25 cm/s)*
- *Opposite phases at the entrance flanks*

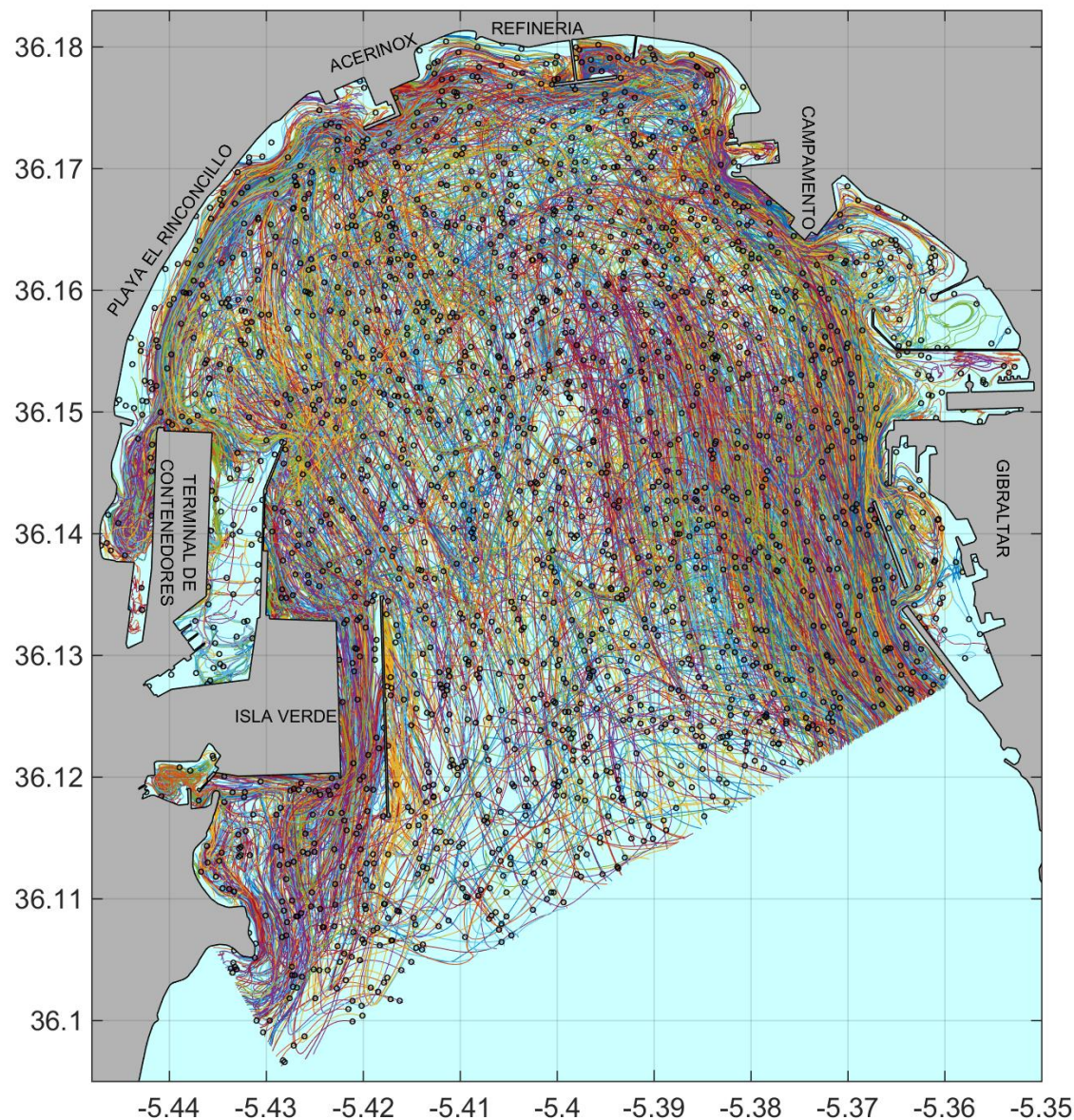
WATER QUALITY ASSESSMENT – HARMONIC ANALYSIS



Port area
One in 3 points!

- *Strongest bidirectionality and highest current speed ($\sim 20 \text{ cm/s}$) through the Isla Verde and Dique Exento channel*
- *Quite stagnant areas in Darsena Norte and Darsena Pesquera*

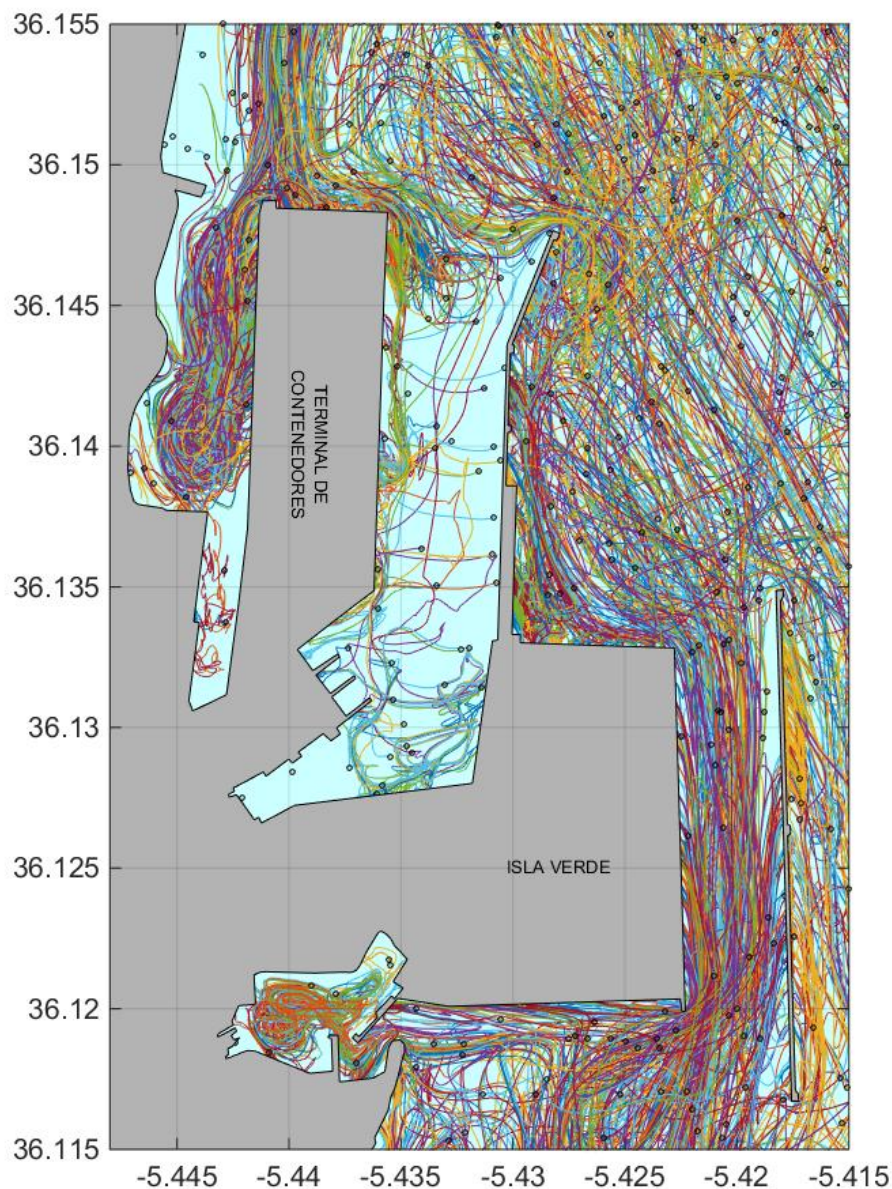
WATER QUALITY ASSESSMENT – PARTICLES TRACKING



Seed area: whole bay

- *Trajectories follow the coast contour*
- *Much higher transit along the lateral flanks than at the entrance*

WATER QUALITY ASSESSMENT – PARTICLES TRACKING

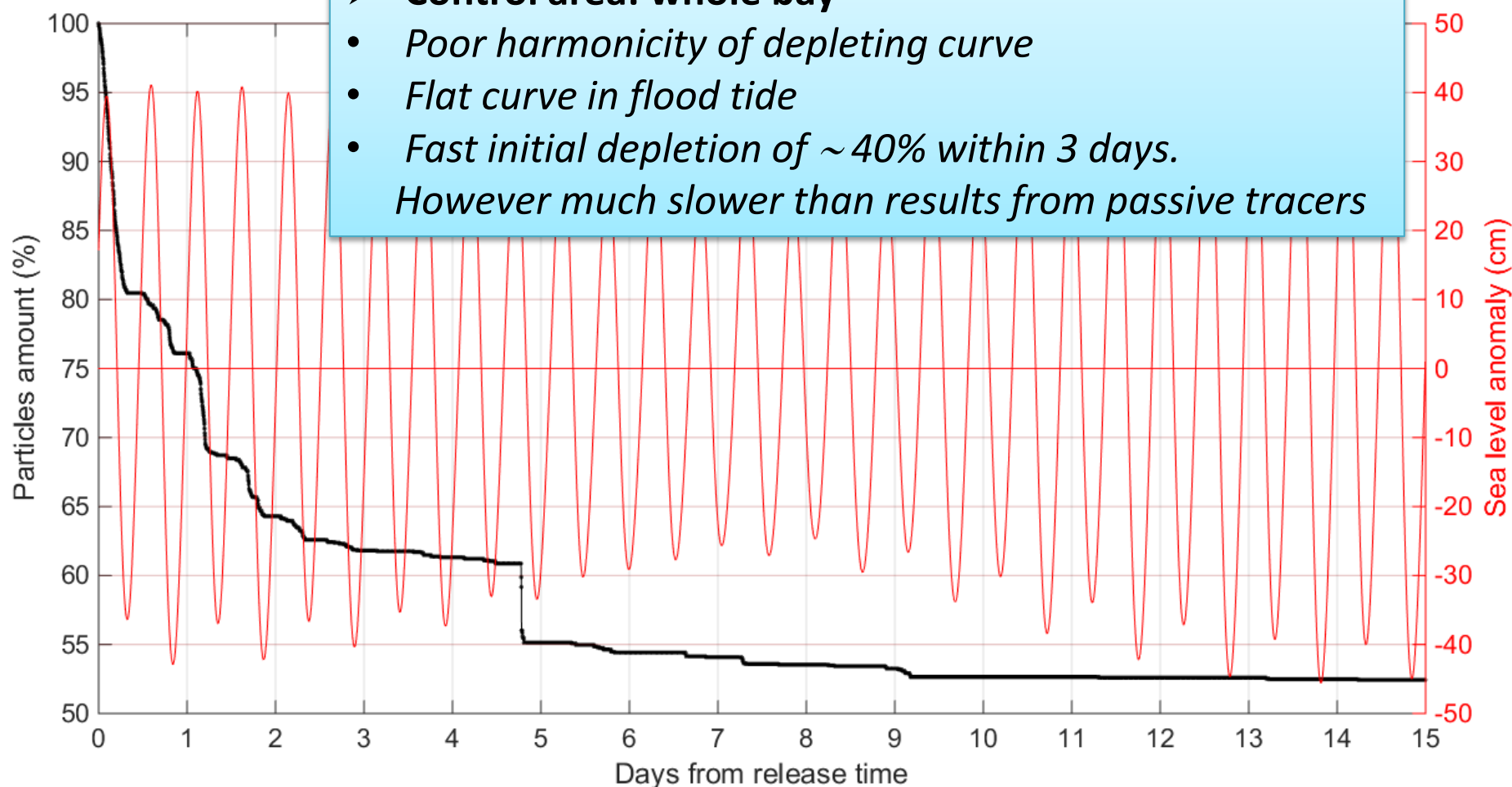


Seed area: whole bay

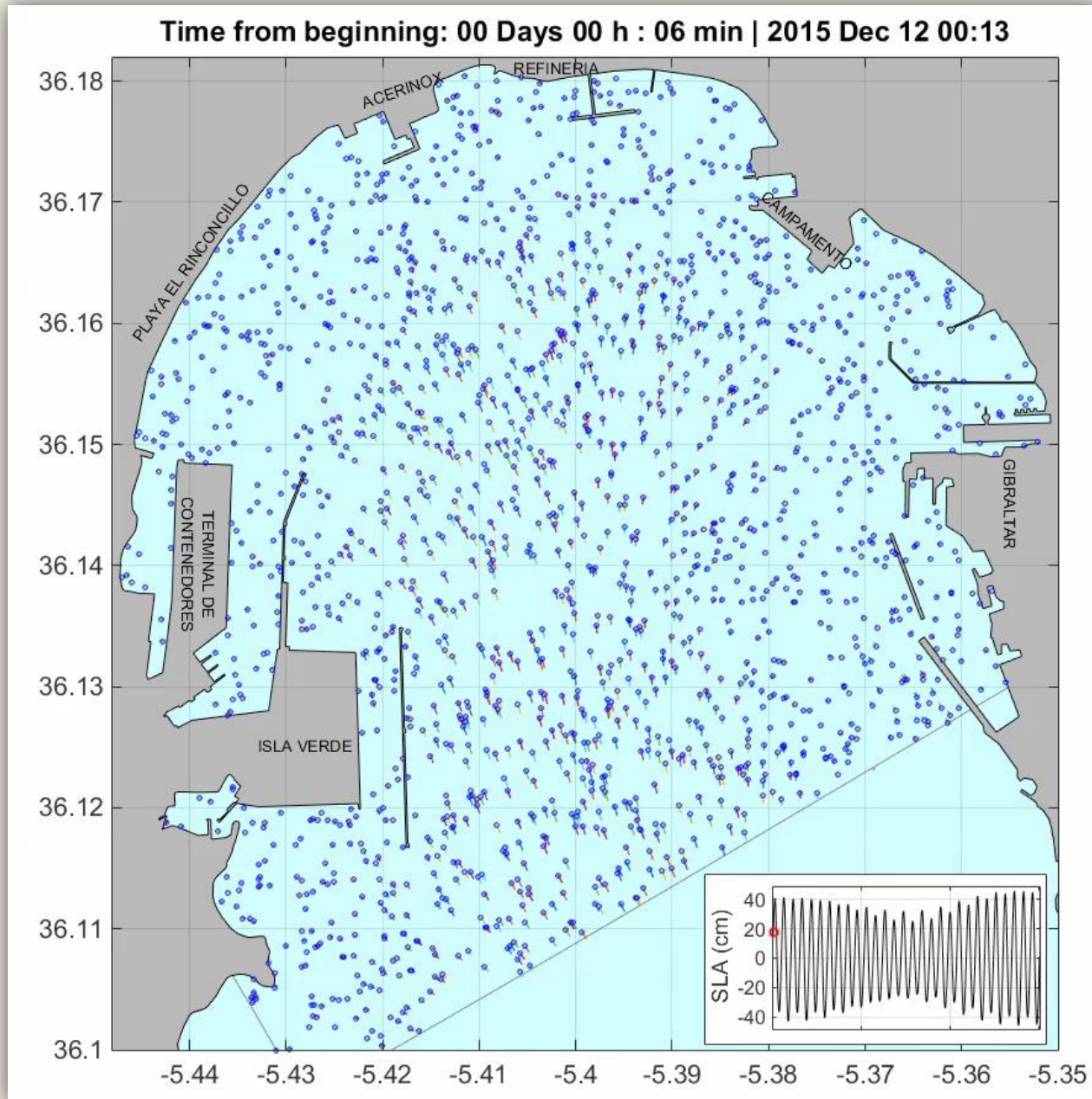
- *Higher dynamics in Darsena Pesquera and Isla Verde – Dique Exento channel*
- *Poor renewal in Darsena Norte*
- *Higher transit over the western margins*

WATER QUALITY ASSESSMENT – PARTICLES TRACKING

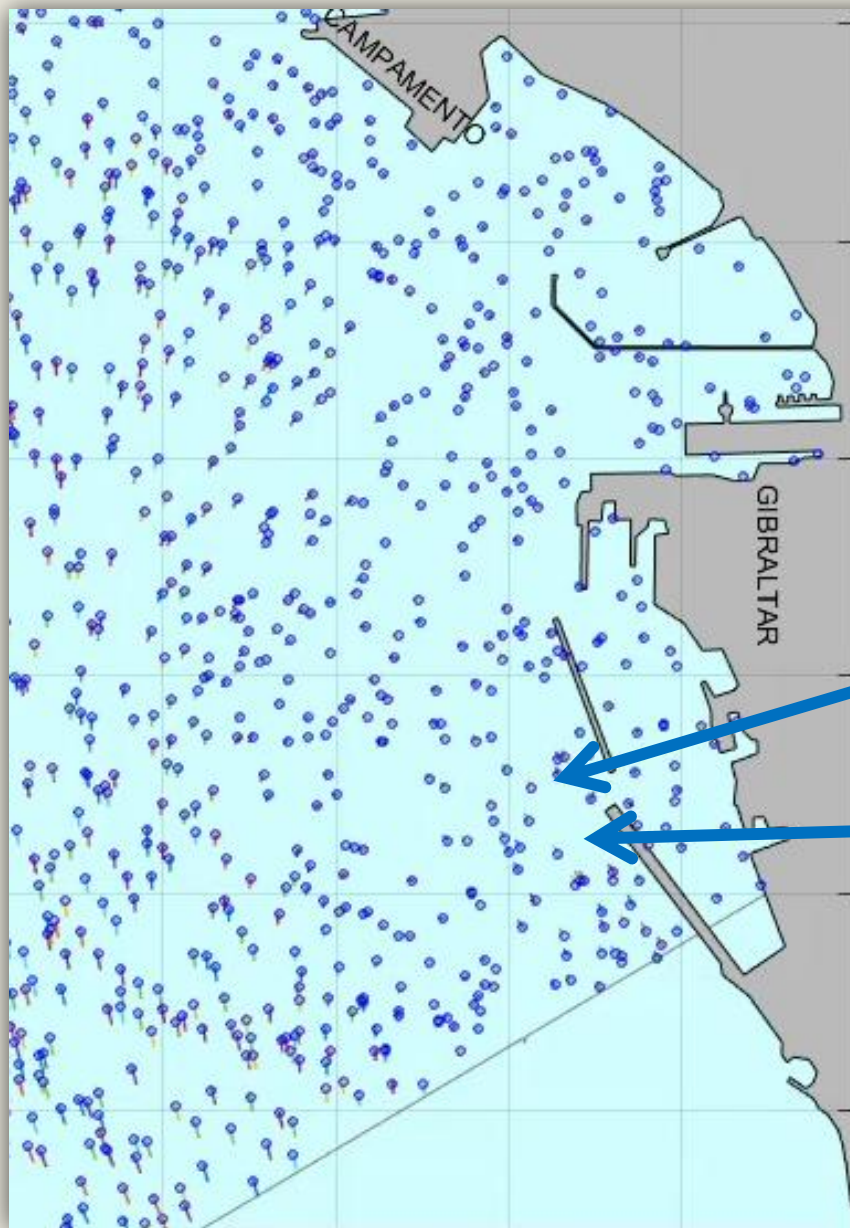
- **Seed area: whole bay**
 - **Control area: whole bay**
 - *Poor harmonicity of depleting curve*
 - *Flat curve in flood tide*
 - *Fast initial depletion of ~40% within 3 days.*
- However much slower than results from passive tracers*



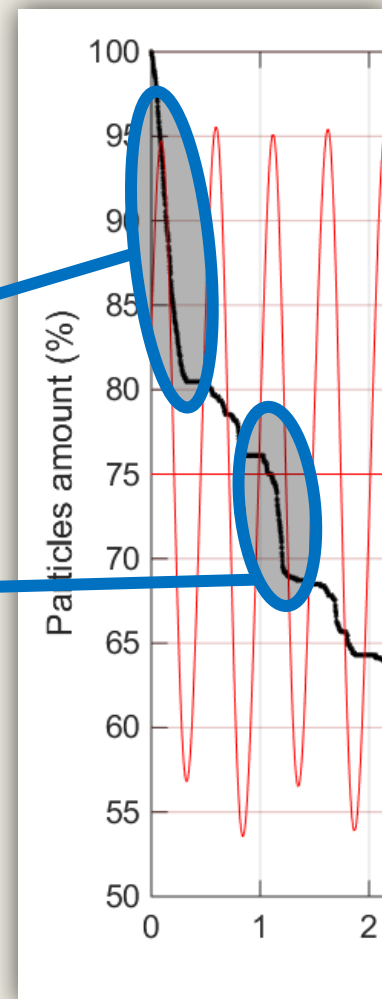
WATER QUALITY ASSESSMENT – PARTICLES TRACKING



WATER QUALITY ASSESSMENT – PARTICLES TRACKING



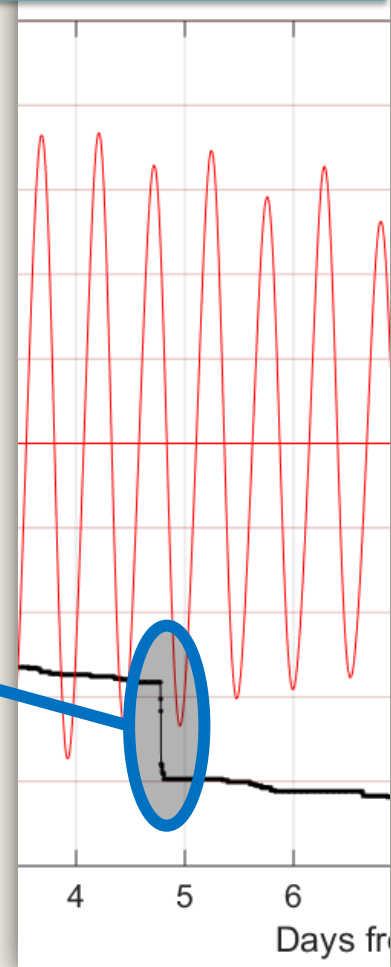
Fast depletion along the eastern flank



WATER QUALITY ASSESSMENT – PARTICLES TRACKING

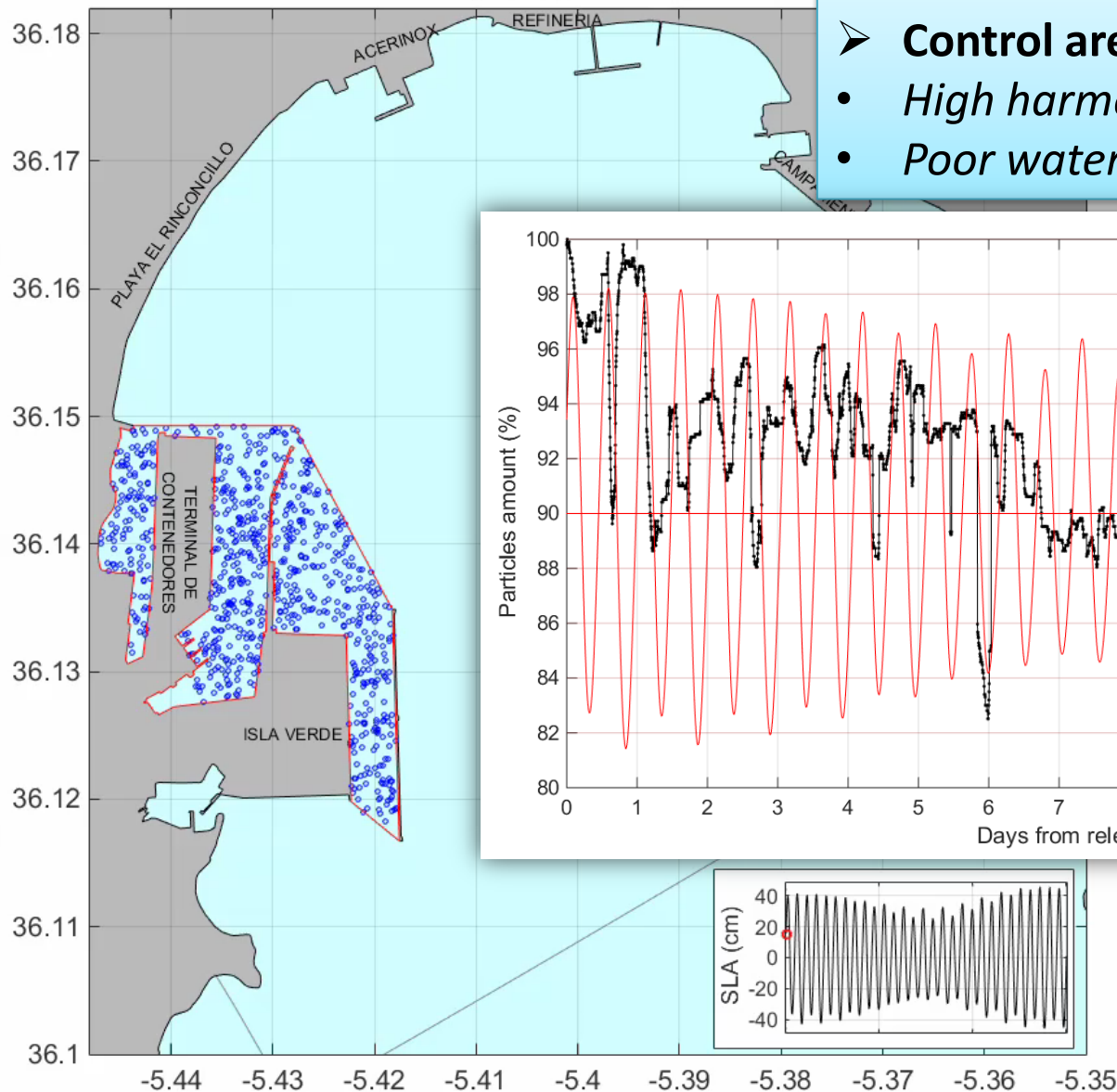


Strong discontinuity due to a particles agglomeration escaping through the eastern flank



WATER QUALITY ASSESSMENT – PARTICLES TRACKING

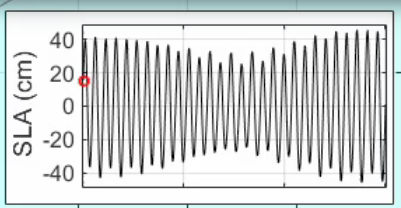
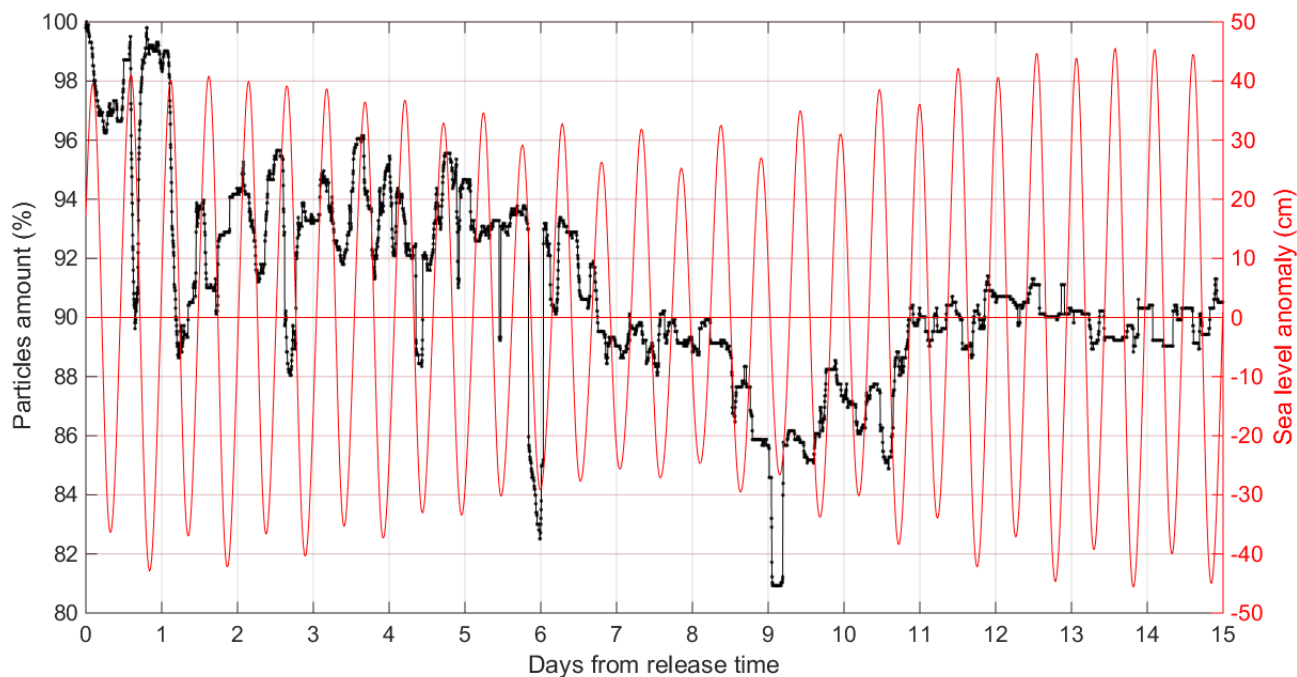
Time from beginning: 00 Days 00 h : 0



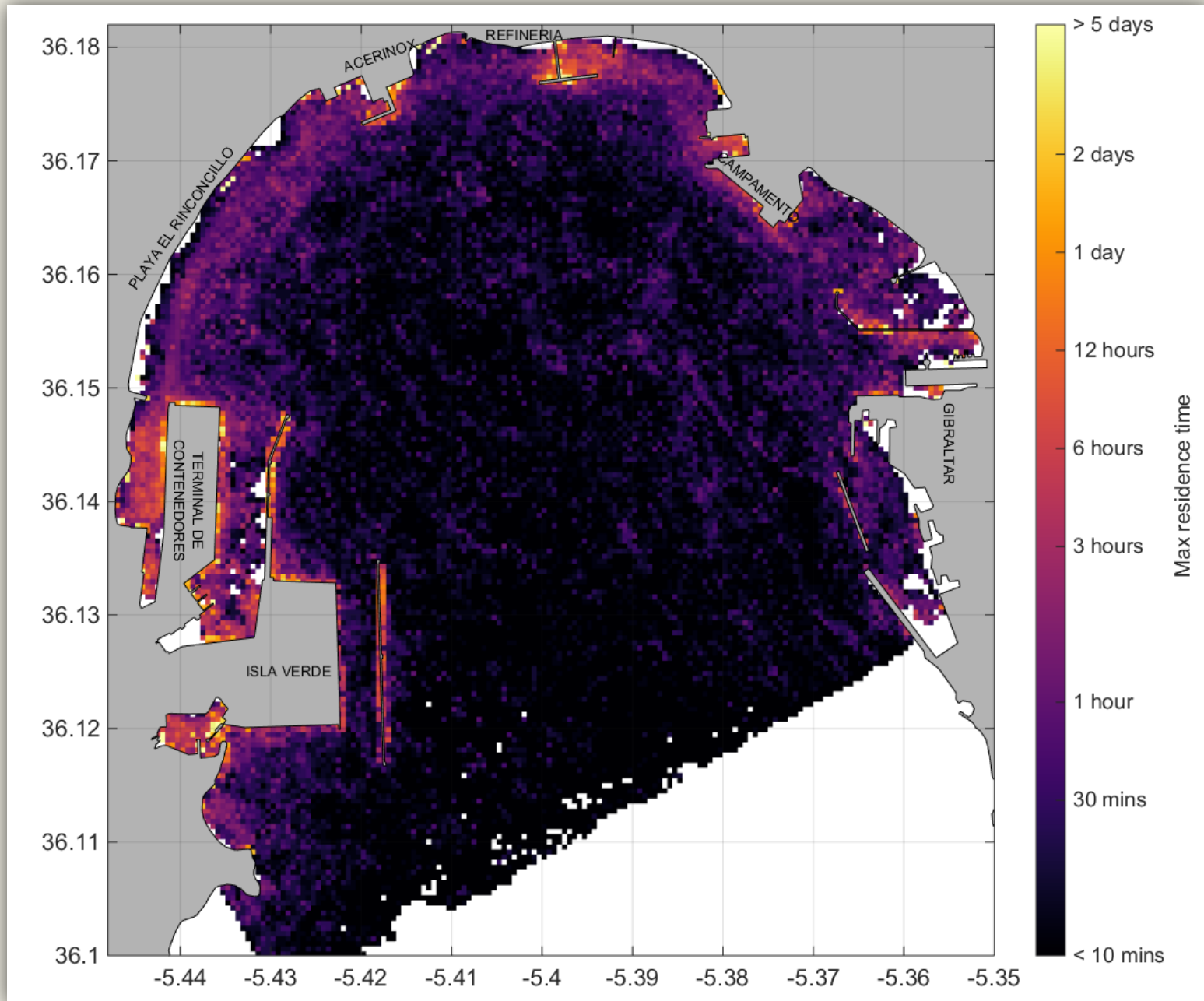
➤ **Seed area: Port**

➤ **Control area: whole bay**

- *High harmonicity of depleting curve*
- *Poor water renewal*

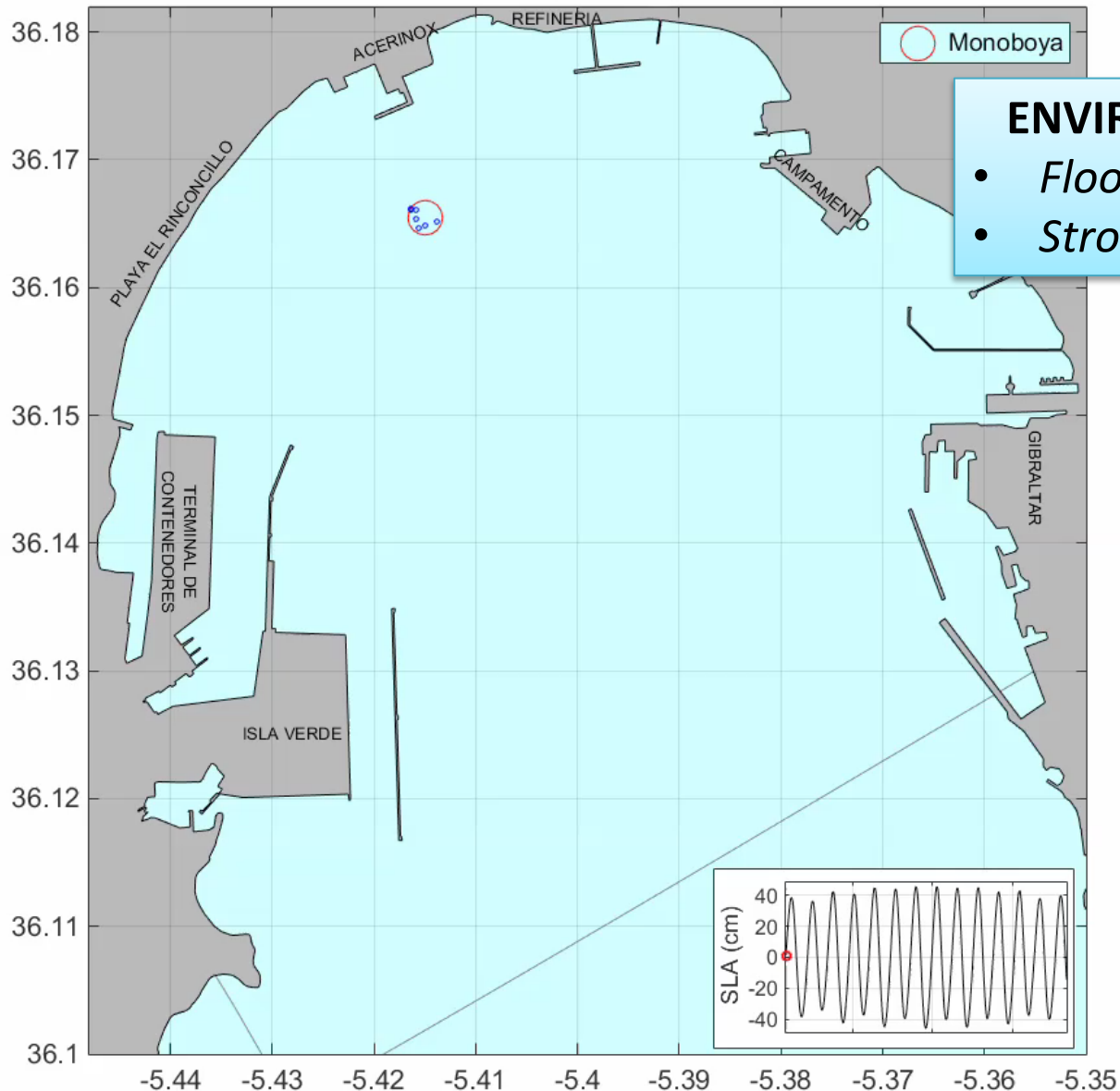


WATER QUALITY ASSESSMENT – PARTICLES TRACKING



WATER QUALITY ASSESSMENT – BAY OF ALGECIRAS OIL SPILL

Time from beginning: 00 Days 00 h : 00 min

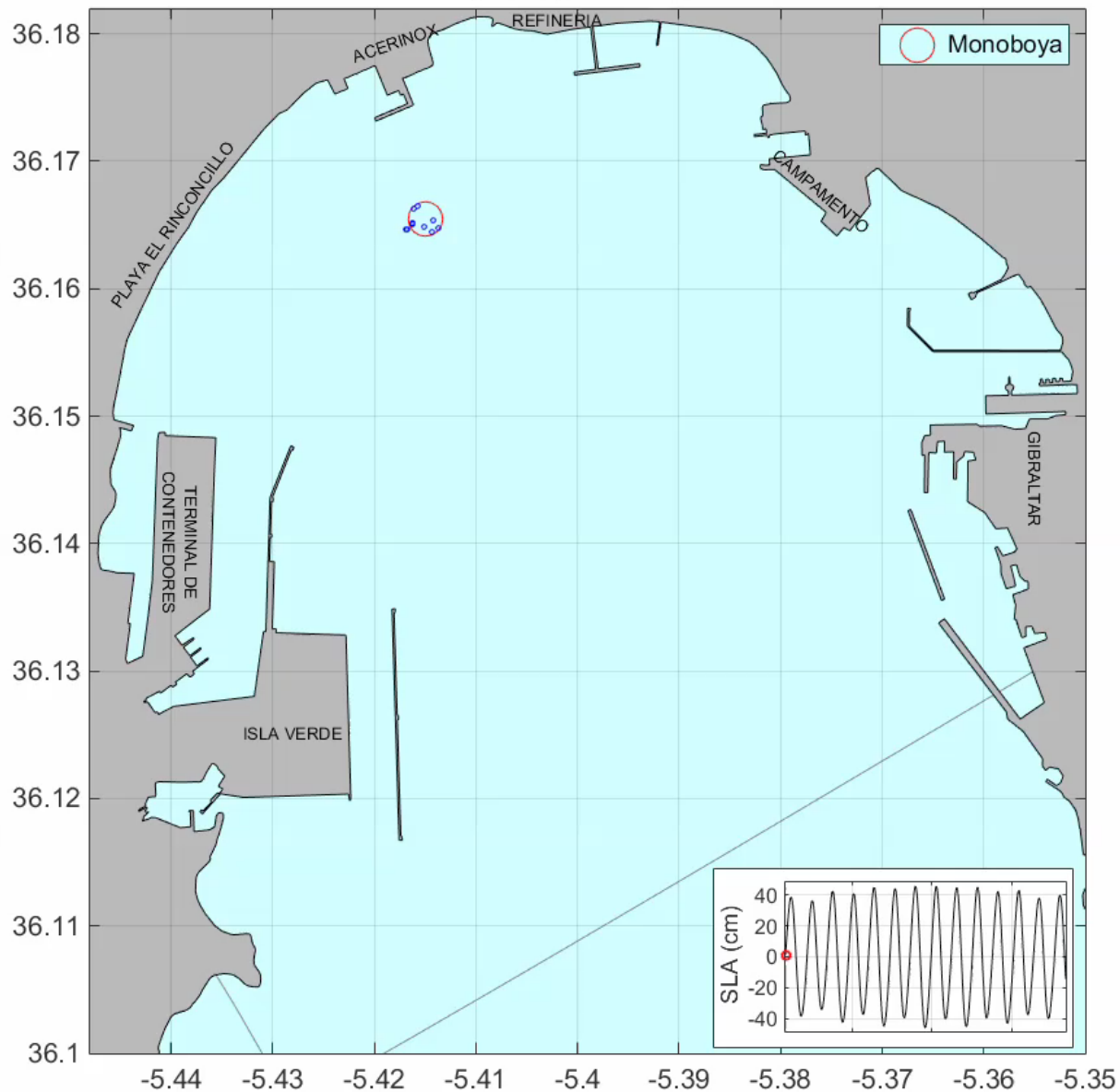


ENVIRONMENTAL CONDITIONS

- *Flood tide*
- *Strong Levante wind*

WATER QUALITY ASSESSMENT – BAY OF ALGECIRAS OIL SPILL

Time from beginning: 00 Days 00 h : 00 min



NO wind