HR Radar Users Workshop

CMEMS Service Evolution INCREASE project
Copernicus Marine Week - Sep 26, 2017 - Bruxelles

HF Radar application for marine litter management: LIFE LEMA project

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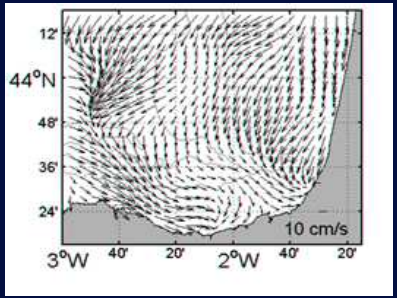

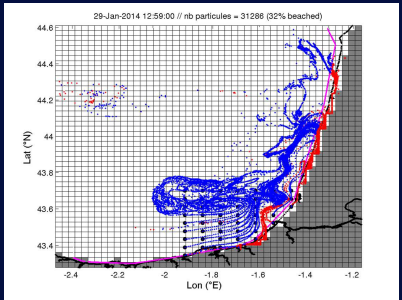

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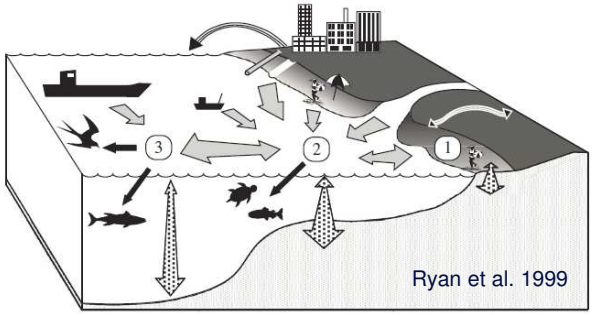
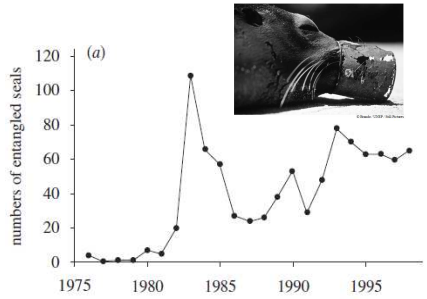
Introduction

The Marine Litter issue

- Marine litter is one of the main ocean pollutions related to human activities
  - **Plastic**, fishing nets, sanitary wastes, etc.
  - **10 Mtn of marine litter** in the ocean every year (European Environment Agency)
  - **Plastic waste** = 60-80% of world's litter → **10% ends up into the oceans** (Derraik 2002)
  - Main inputs: **beaches, rivers, storm water runoff, wastewater discharges** (Ryan et al. 1999)
  - UNEP 2005: 15% beach onshore (1), 15% drift in the surface ocean (2), 70% sink toward the deeper ocean after drifting in the surface layer (3)
- Many impacts
  - **Environment & Ecology**
    - **Ingestion by fishes, turtles, marine mammals** + **entanglement**, impede fish movement
    - **Contaminant fixation** on plastic wastes (e.g. bacteria), degradation toward **microplastic**
  - **Economy**
    - Touristic activities, recreational use of beaches
    - Obstacles for navigation
    - Significant **cost of litter collection** onshore/offshore → **~350 M€/year** for EU coasts
- Marine Strategy Framework Directive targets marine litter (Directive 2008/56/CE)
  - Good ecological state to be reached in 2020
  - **Descriptor #10 → Marine litter**

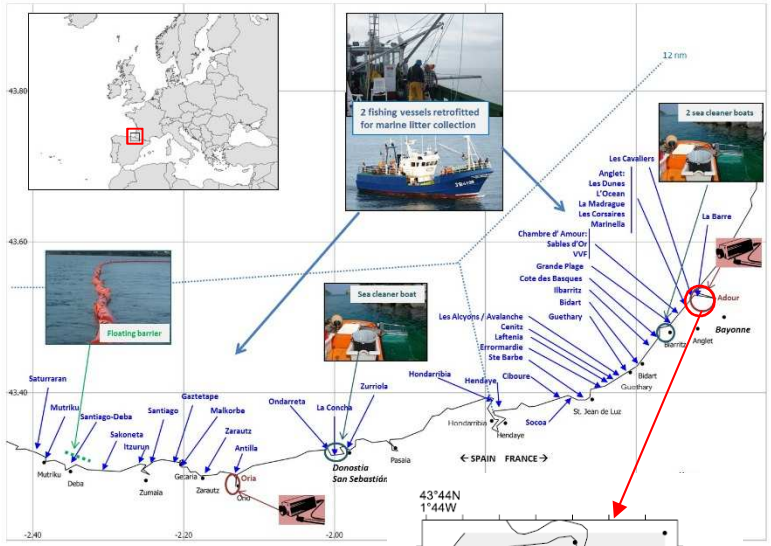


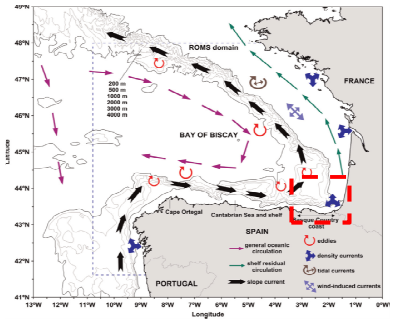


Introduction

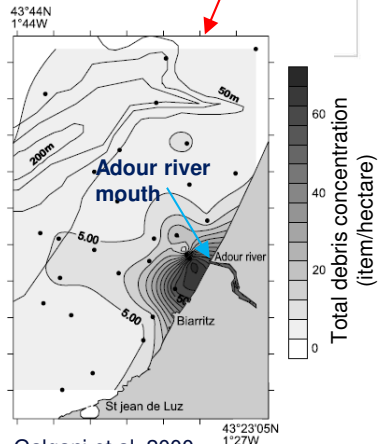
LIFE LEMA project

- Funded by the EU LIFE program. Duration: 2016-2019
- Objectives
  - **Support FML management by local authorities** → collection operations, source identification, collected waste valorization
  - Improve **knowledge about FML** dynamics in the **coastal area** → **Metocean** tools
  - Improve **offshore collection efficiency** → Fishing vessels, FML hotspot targeting, routing optimization
  - Anticipate **onshore arrivals**
- Focus on
  - **Macro-litter** (typical size > 20 cm)
  - **Floating** Marine Litter → Coastal area
  - **Beached** Marine Litter → Nearshore/Onshore areas
  - Study area: **SE Bay of Biscay** (Spain/France)
- Partners
  - Deputacion Floral de Gipuzkoa → Leader
  - Agglomeration CAPB (Kosta Garbia), Biarritz city
  - AZTI Tecnalia, SUEZ center Rivages Pro Tech
  - Surfrider Foundation Europe





Ferrer et al. 2009

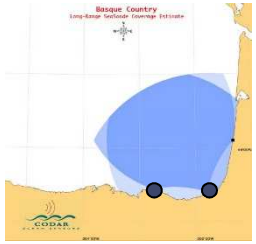


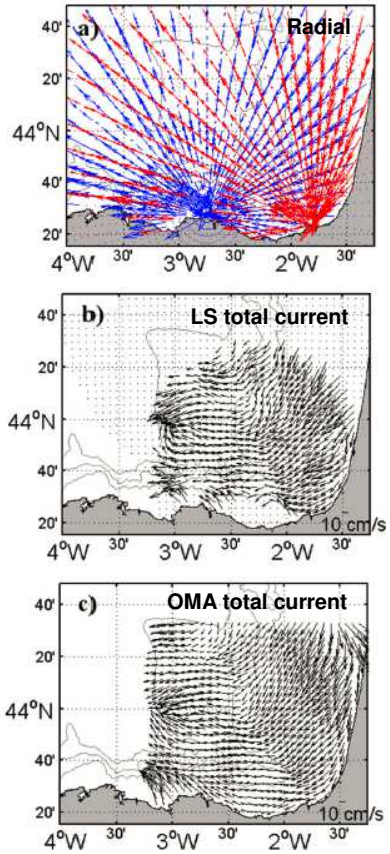
Galgani et al. 2000

Data

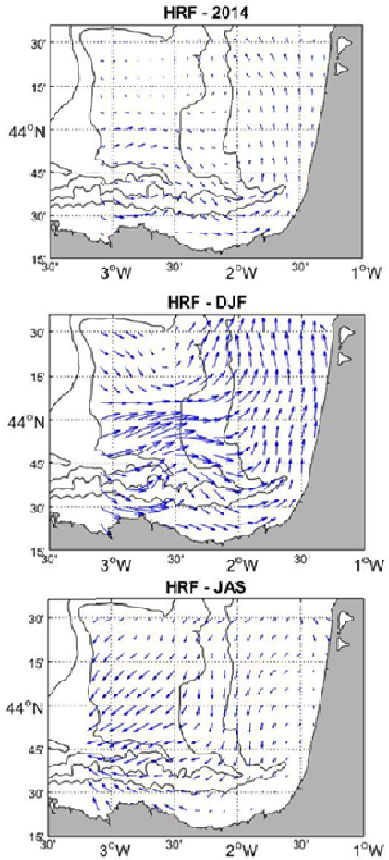
Surface current fields from HF Radar system

- Euskalmet HFR system operated by AZTI Tecnalia
- Two antennas on the Spain north coast
- Data processing (see Rubio et al. 2017)
  - Least Square (LS) algorithm
  - OMA method
- Surface current fields
  - Current velocity components U,V
  - Area: [-3.2°E,-1.2°E], [43.27°N,44.58°N]
  - **Regular horizontal grid 5 x 5 km**
  - **Hourly data**





Rubio et al. 2017



OMA current annual/seasonal mean

Data

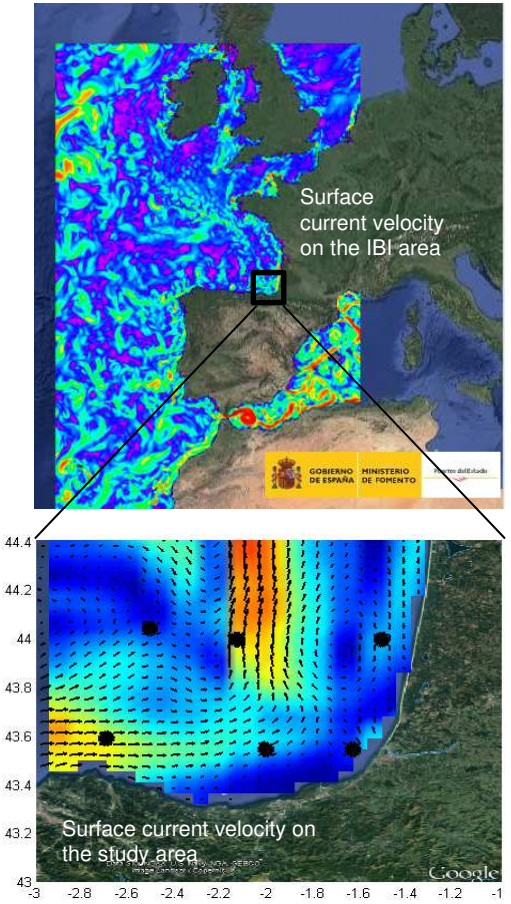
Surface current field from Copernicus model

- **IBI Ocean Analysis and Forecasting system**
  (CMEMS product: IBI_ANALYSIS_FORECAST_PHY_005_001_b)
  - NEMO hydrodynamic model forecast and analysis
  - Variables available: water level, currents, temperature, salinity

- Variable used: 3D or 2D surface current velocity field

- Model grid
  - Horizontal: **regular grid 2 x 2 km**
  - Vertical: 50 vertical layers (cartesian)

- Time step (hindcast data)
  - **Daily** 3D fields
  - **Hourly** 2D surface fields



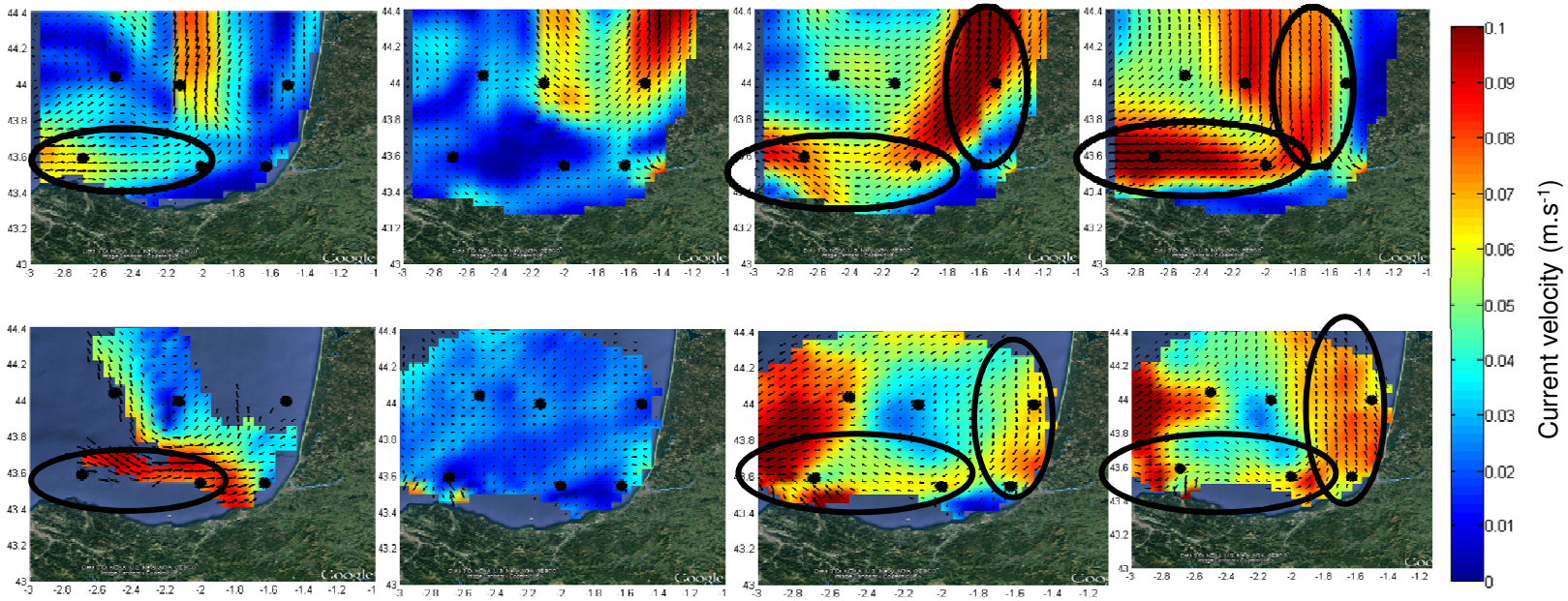
Model-data comparison

Surface current fields: Eulerian comparison

- Copernicus model v.s. HF Radar velocity fields based on 3 years of data (2014-2015-2016)

Model

HF Radar



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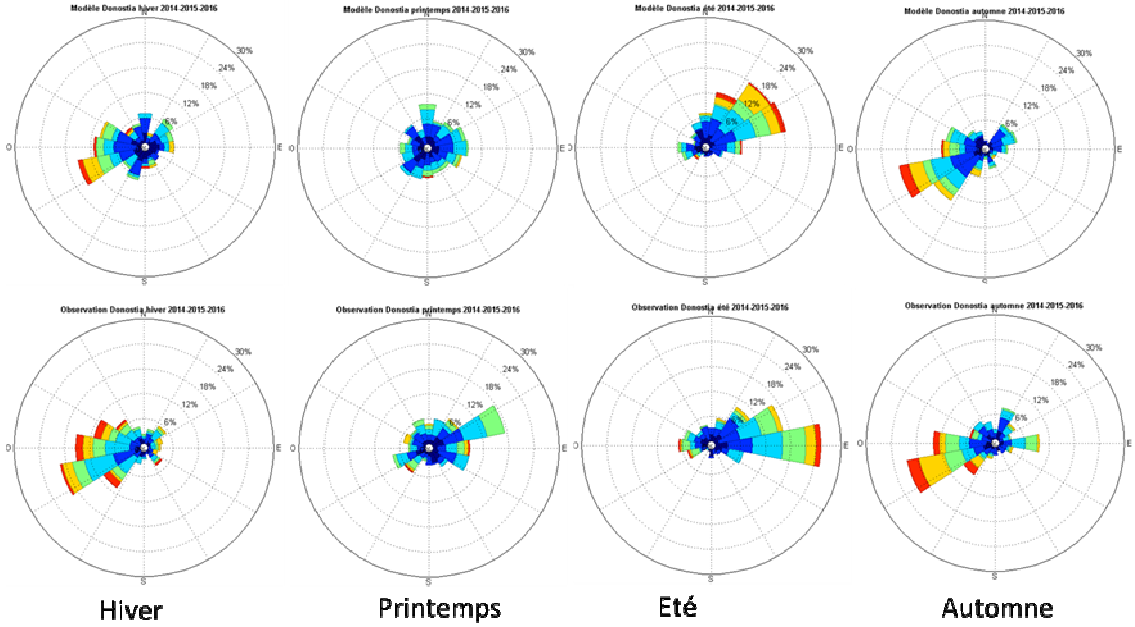
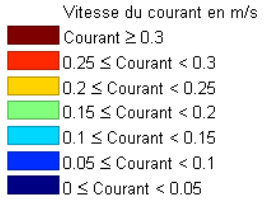
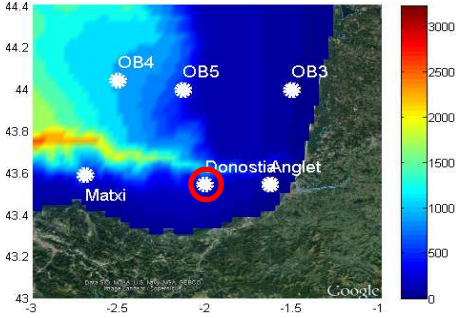






Model-data comparison

Surface current fields: Eulerian comparison

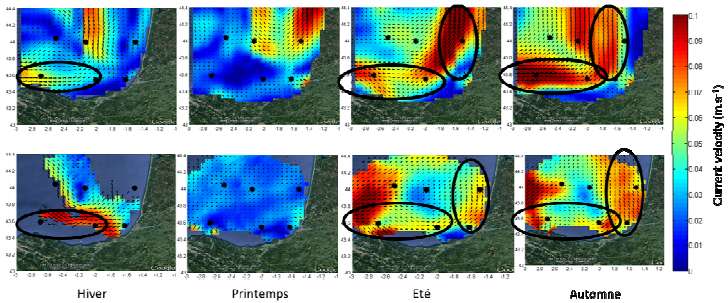
- Copernicus model v.s. HF Radar velocity fields based on a 3 years control period (2014-2015-2016)

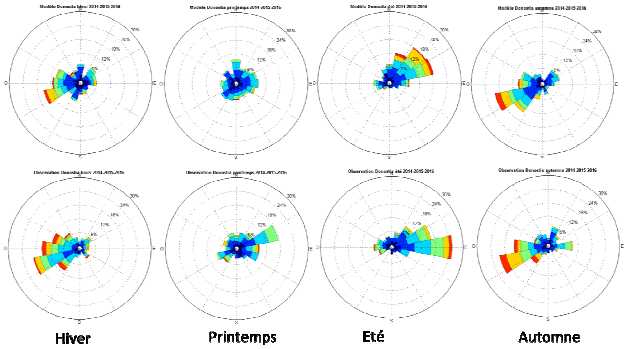
- Encouraging model-data agreement
  - Fair agreement in deep water
  - Reasonnable representation of the slope current
  - Several major seasonal patterns captured over the shelf

- However significant differences remain
  - Spring regime
  - Position and extension of the slope current
  - Important local differences over the inner shelf

- Questions
  - → What is the impact of these differences for the study of surface transport ?
  - → Can IBI model be used to simulate/forecast FML transport ?

→ **Use of a Lagrangian approach**



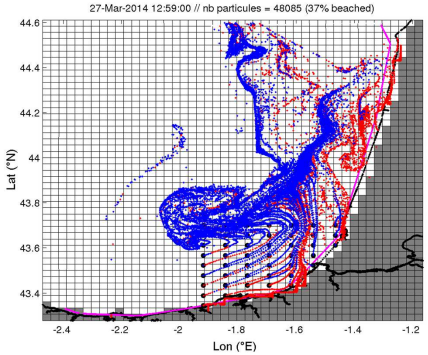


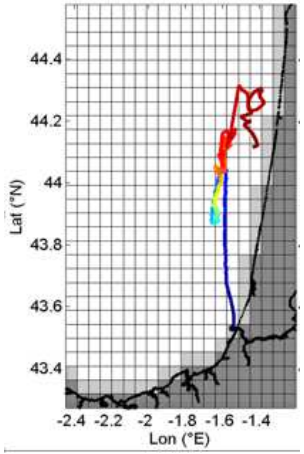
Lagrangian Transport Model

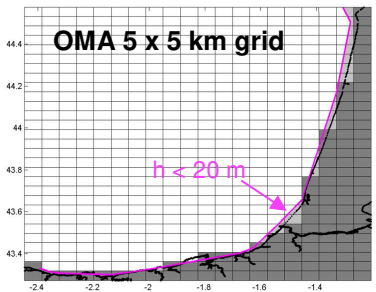
Lagrangian modelling of ocean surface transport

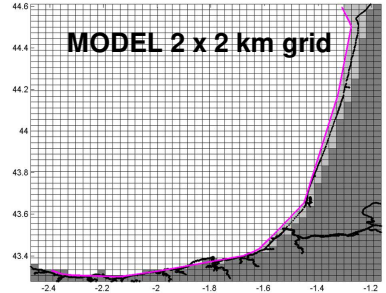
- MOHID Water modelling system (Martins et al. 2001; Braunschweig et al. 2004)
  Lagrangian transport module (Leitão 1996)
  - Main functionalities
    - 2D or 3D tracers advection by multiple current fields
    - Turbulent mixing effects: diffusion (Allen 1982) + dilution (volume increase)
    - Allows to account for direct wind effect at the surface
    - Intertidal areas management
    - Properties transport (water quality, etc.)
- Implementation for this study
  - **2D advection by surface current** fields from HFR and Copernicus
  - Horizontal **diffusion** (depending on the simulation)
  - **Zero direct wind effet**
  - Specific post-processing procedure to **account for beaching** possibility in the nearshore
- Tracers release
  - **Costal area release**: on a regularly spaced grid, 1 particle/hour
  - **River mouth release**: in front of the Adour river mouth, depending on river flow

→ 3 months test simulation (winter regime)









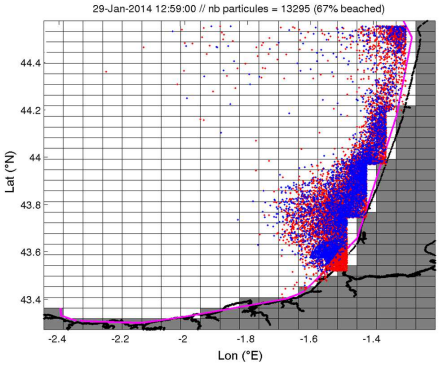
Lagrangian analysis

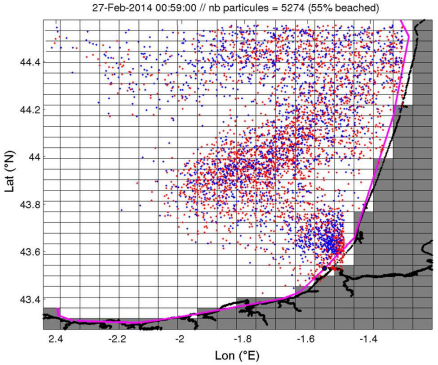
Lagrangian modelling of ocean surface transport

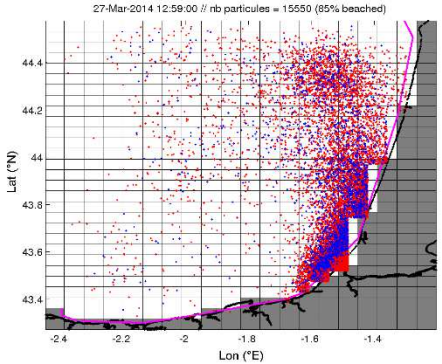
Potentially Beached // Never on littoral points

- Case Adour release

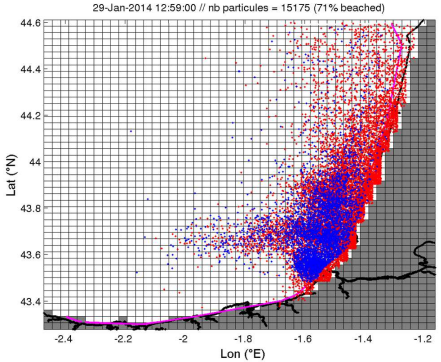
HF Radar

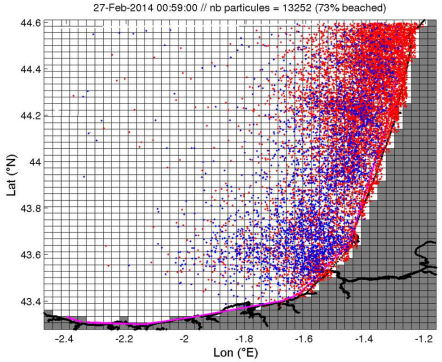


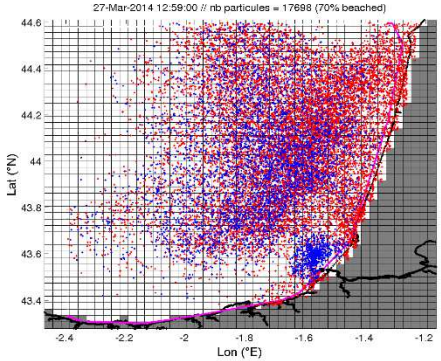




Copernicus model



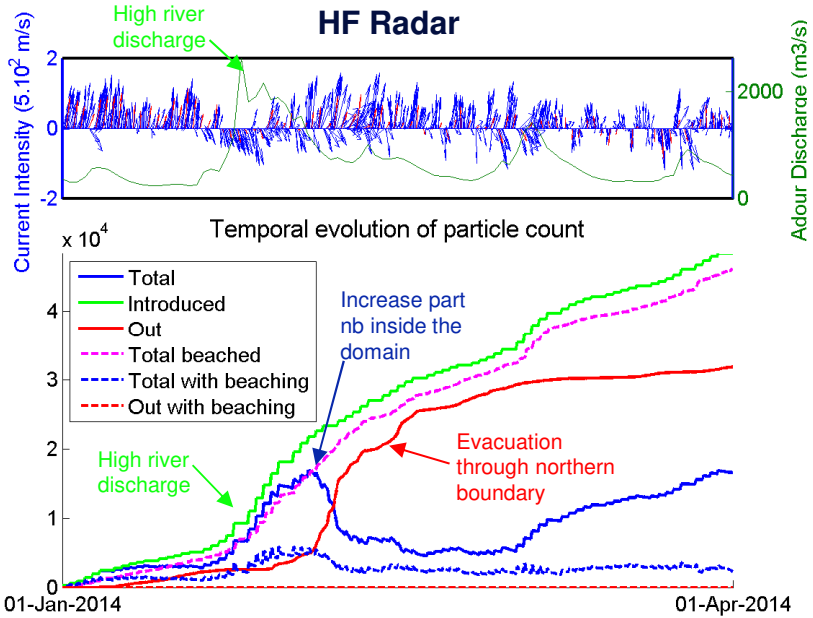


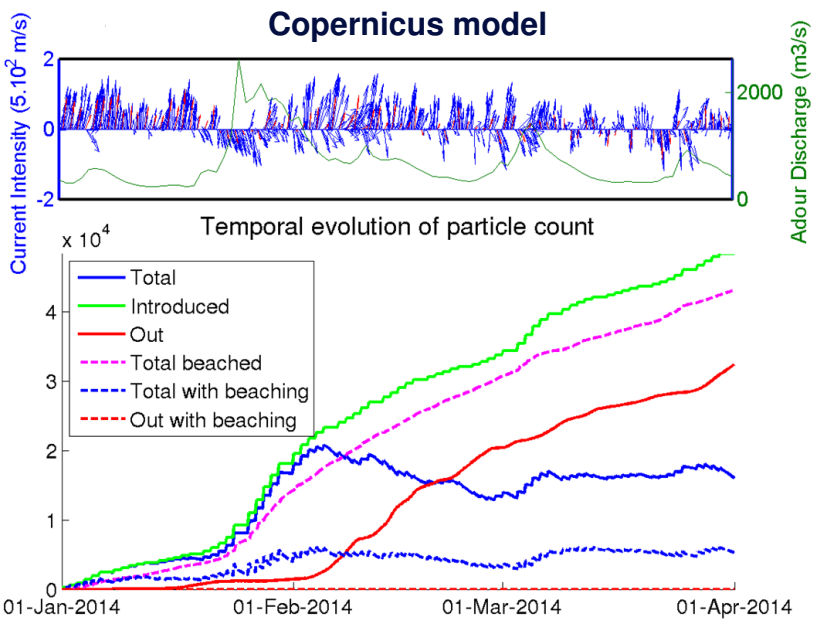


Lagrangian analysis

Global tracers balance in/out the domain

- Time evolution at the scale of the domain - Case Adour release



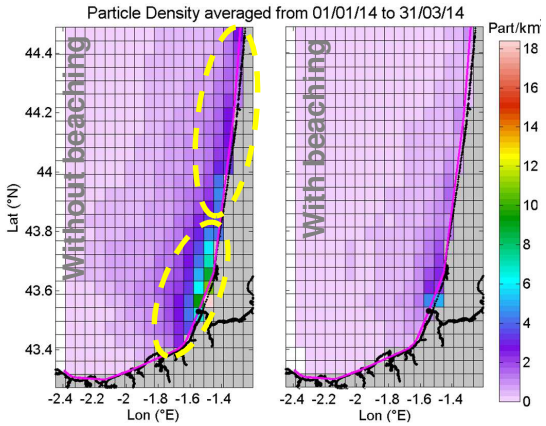


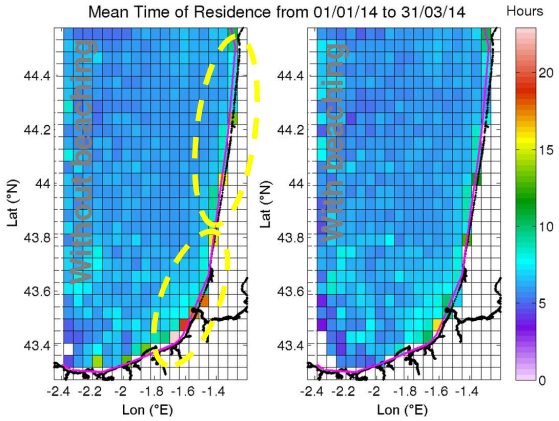
Lagrangian analysis

Adour river release

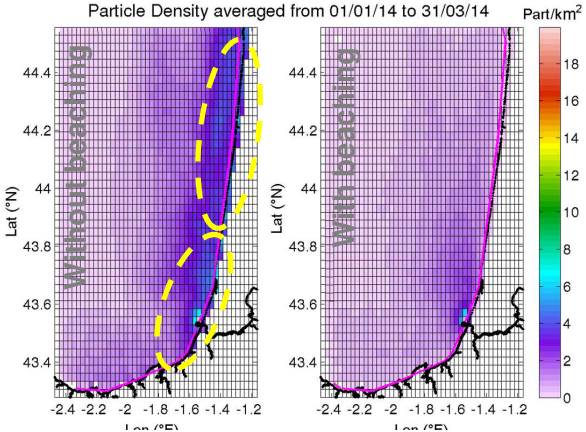
- Density maps
- Residence Time maps

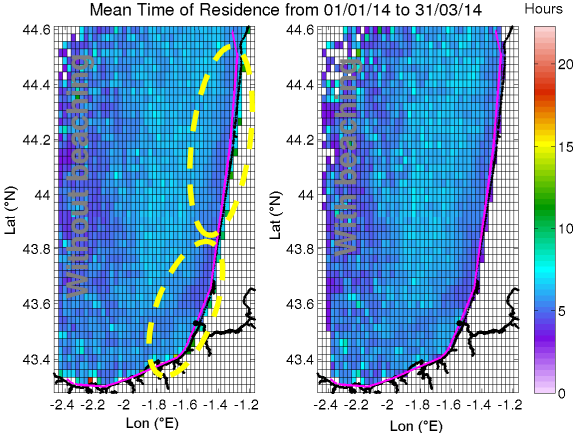
HF Radar





Copernicus model



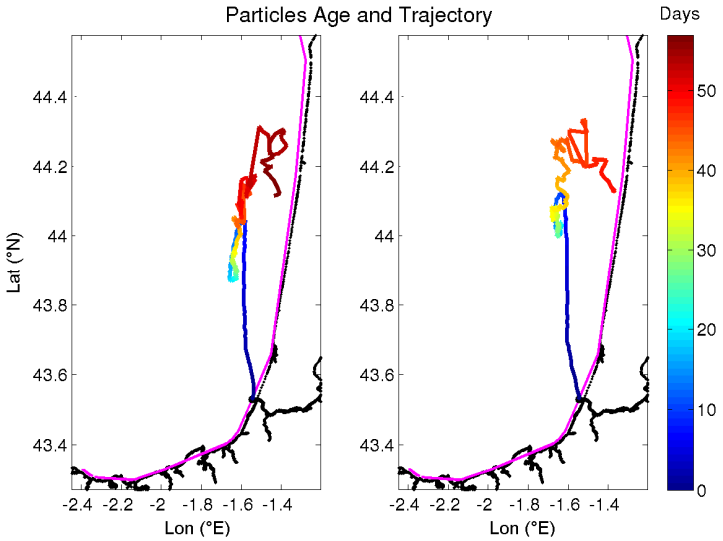


Lagrangian analysis

Mean trajectories

- Case Adour river release (with diffusion). Specific time period or meteocean regime

HF Radar



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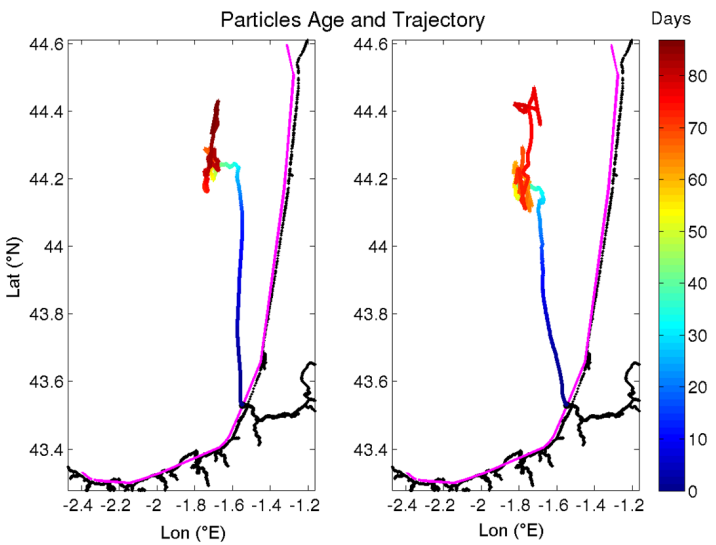


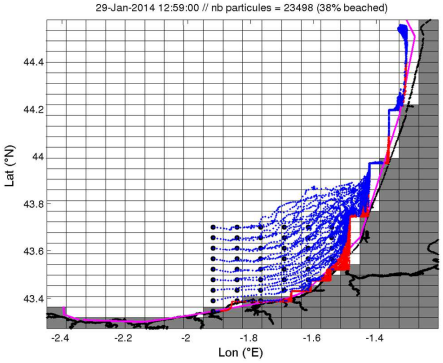
Lagrangian analysis

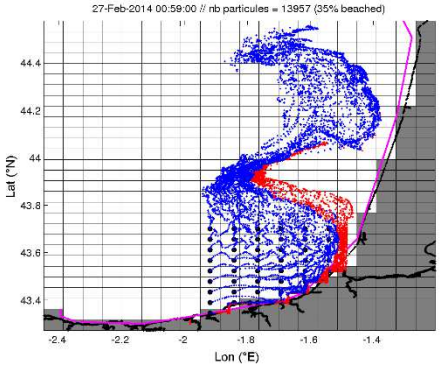
Lagrangian modelling of ocean surface transport

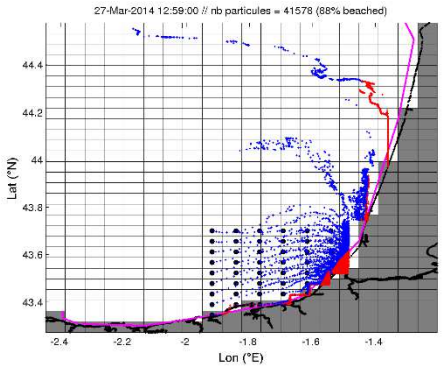
Potentially Beached // Never on littoral points

- Case coastal release

HF Radar







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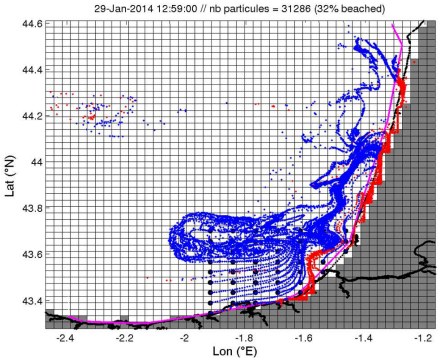
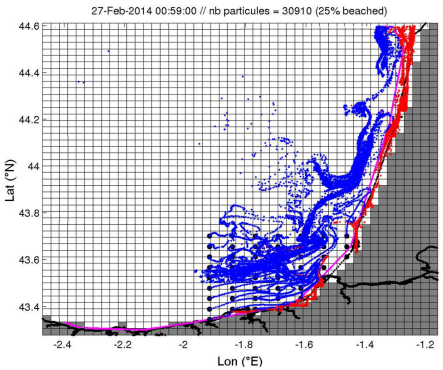
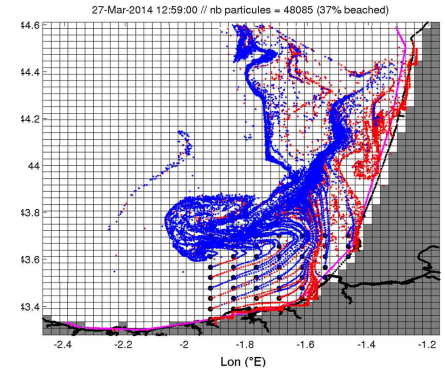




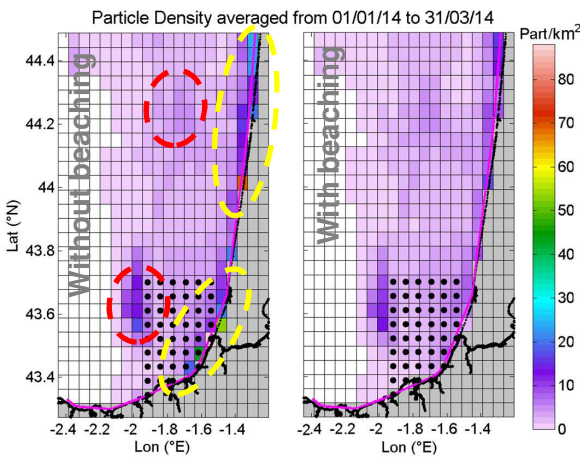


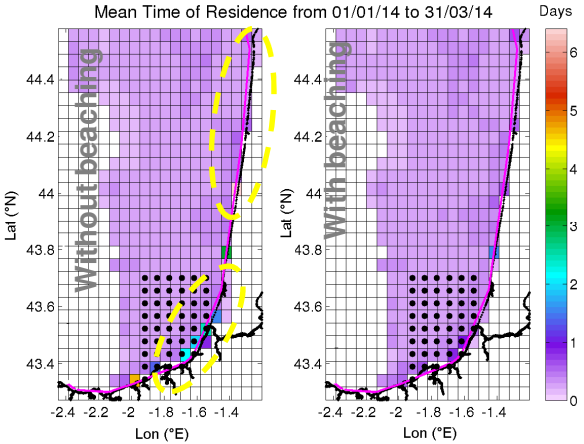
Lagrangian analysis

Coastal release

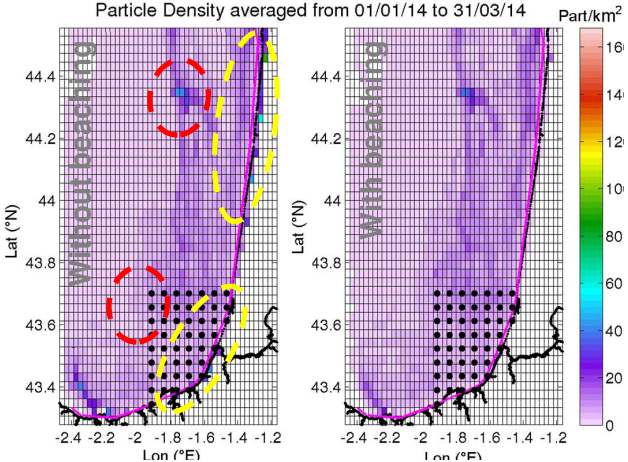
- Density maps
- Residence Time maps

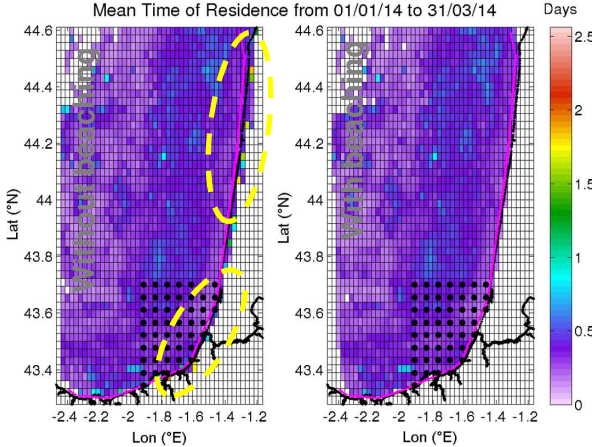
HF Radar





Copernicus model





Conclusions

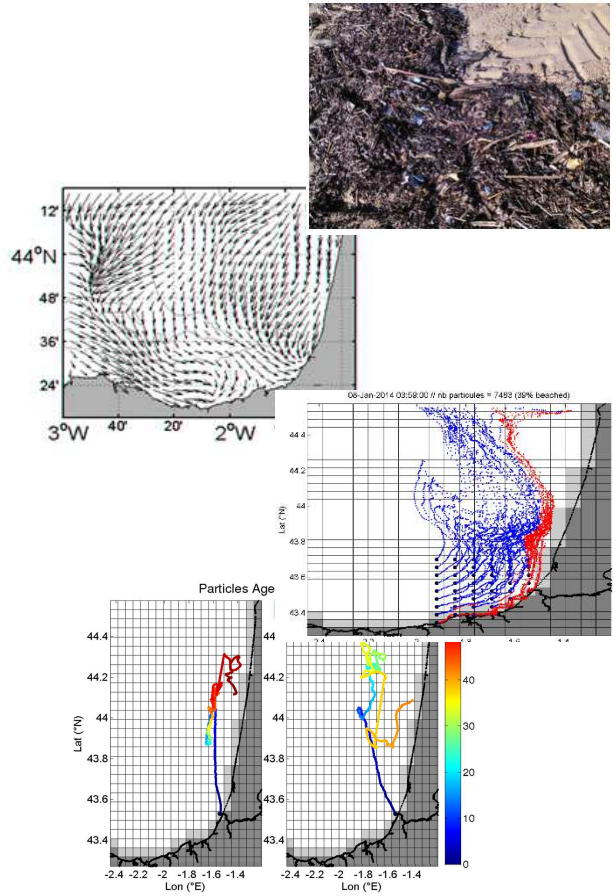
The support of HFR data for the study FML transport

- Eulerian comparison of HFR with Copernicus IBI surface currents gives encouraging results (3 years control period)

  → **What about the use of IBI model for FML transport ? → Lagrangian approach**

- Lagrangian transport model forced by HFR or Copernicus currents
  - Results analysis and comparison based on **different diagnostics: 3 months test period**
  - Reasonable HFR/Copernicus results **global agreement**…
  - …but significant **local differences**, especially for the coastal release case
  - Emphasizes important role of the nearshore area:
    - **exchanges between nearshore and coastal area**
    - **beaching process**

- Further work
  - Lagrangian HFR / Copernicus comparison over the **3 years control period**
  - Lagrangian model **validation against observations**: drifters, surface ocean colour images
  - **Downscaling** Copernicus solution to solve **nearshore dynamics**
  - Work on **beaching parameterization**



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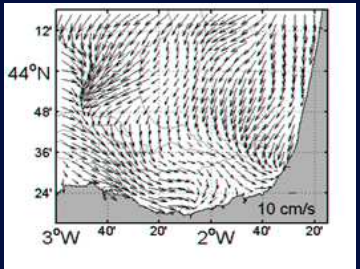
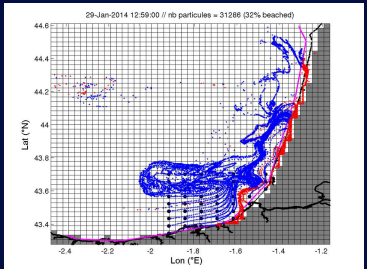
HF Radar application for marine litter management: LIFE LEMA project

Thanks for your attention !





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