



# Cedre Information Day

27 March 2013

## MIGR'HYCAR project

Olivier BERTRAND

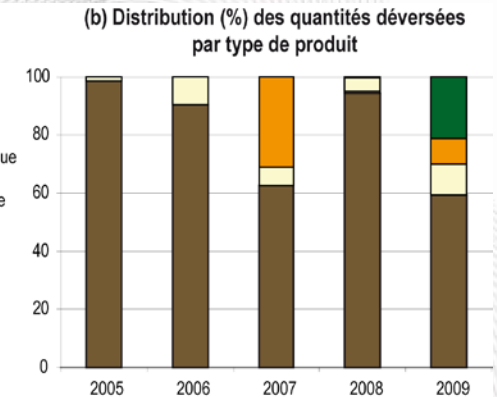
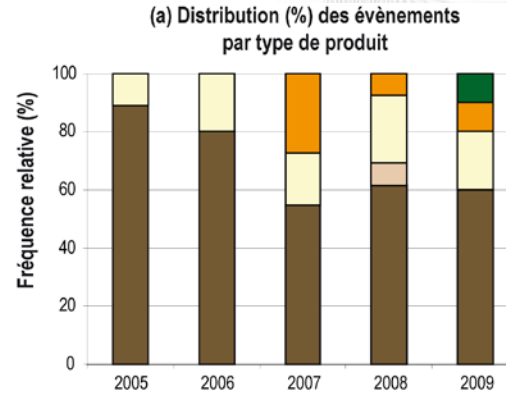
Hydraulic Modelling and Software Department

## OPERATIONAL RISK MANAGEMENT OF OIL SPILL DRIFTS IN CONTINENTAL WATERS

- The MIGR'HYCAR project, funded by the French National Research Agency (ANR) for a 4-year period, aims to develop, validate and finalise a tool for managing risks related to oil spills in rivers and estuaries.
- The MIGR'HYCAR project objectives cover three complementary areas:
  - production of an online **hydrocarbon physicochemical behaviour database**
  - development of **deterministic oil slick monitoring software**
  - definition of a **decision making and water resource management aid software prototype** for emergency situations.

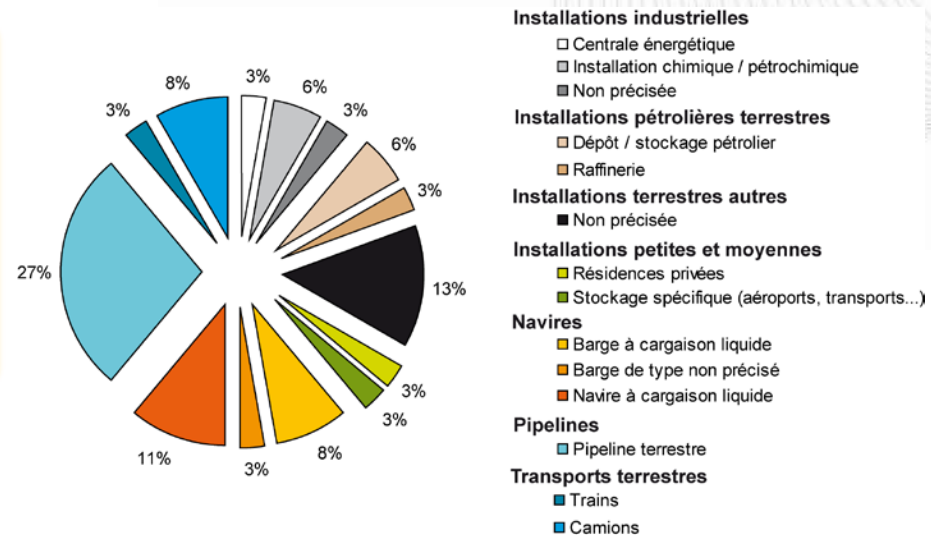
## Issue underlying the project

## PAN-EUROPEAN ANALYSIS



Pluriannual evolution of the relative distribution of (a) events by product type, and (b) quantities spilled by product type (spills > 7 tonnes) in continental and estuarine waters in Europe during the period 2005-2009.

Frequency (%), by structure type, of significant spills (volume > 7 tonnes, with sufficient information) having polluted continental or estuarine waters in Europe, during the period 2005-2009.

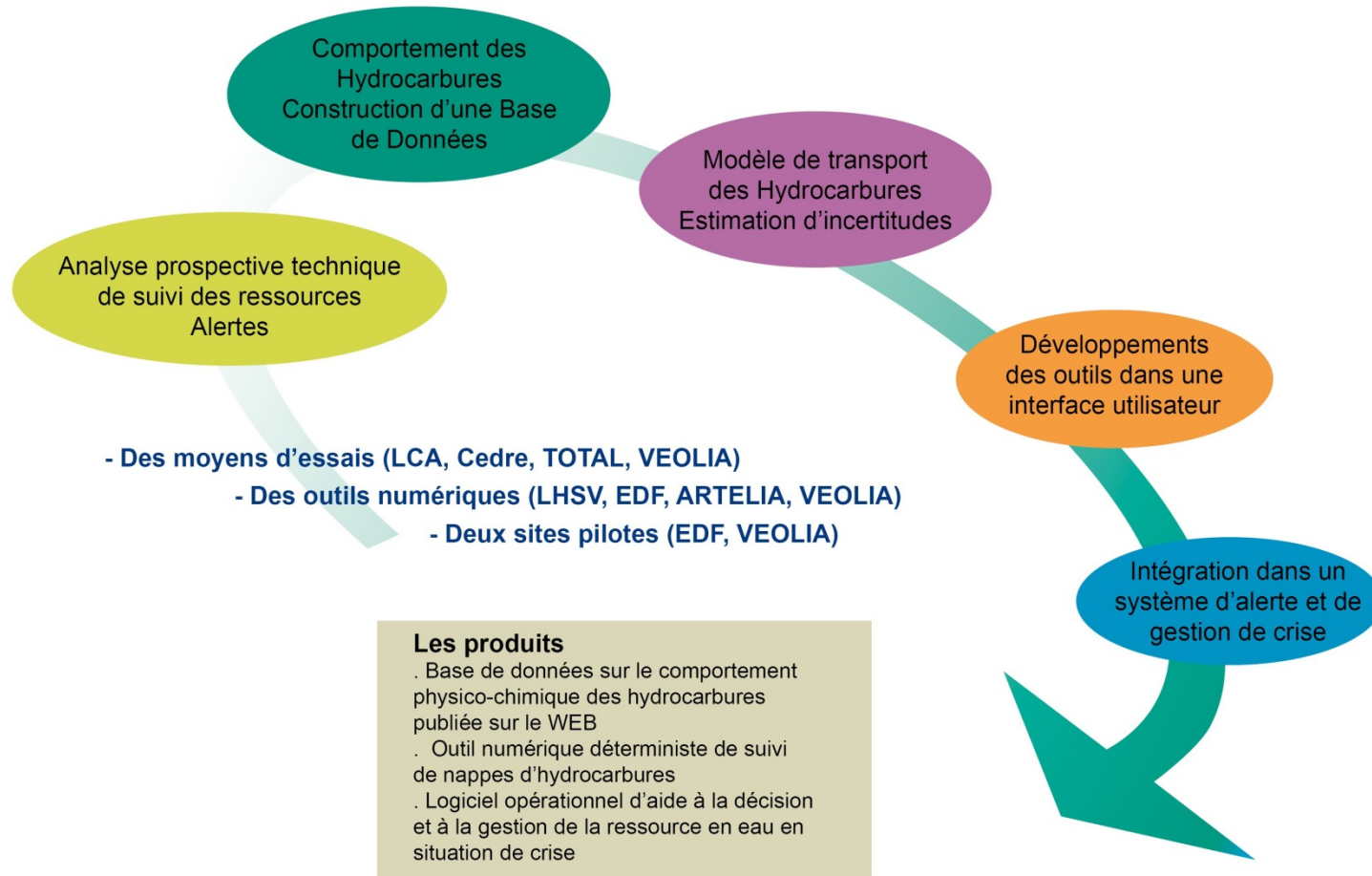


## A carefully honed consortium to meet project objectives

- The project began in February 2009, in the framework of the PRECodd ecotechnology and sustainable development programme implemented by the French national research agency (ANR); it is led by a consortium of 7 partners (ARTELIA, Veolia Environment Research and Innovation (VERI), the Laboratory of Agro-industrial Chemistry (LCA), the Saint-Venant hydraulics laboratory (LHSV), the Centre of Documentation, Research and Experimentation on Accidental Water Pollution (CEDRE), EDF, and TOTAL)
- ARTELIA is coordinating the project and is particularly involved in deploying the database on-line, developing and validating the deterministic tool and operating the warning system on the pilot site in the Loire estuary.
- The project's website ([www.migrhycar.com](http://www.migrhycar.com)) provides greater external visibility.



## Structure & organisation of project tasks





## Evaluation of hydrocarbon physicochemical behaviour

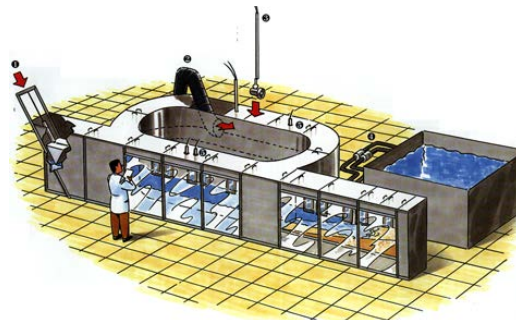
### Products

- fuel oil (IFO 380)
- bitumen (Azalt 35/50)
- diesel
- domestic fuel oil
- petrol (unleaded 98 octane)
- petrol (unleaded 95 octane - E10)
- kerosene (jet fuel)

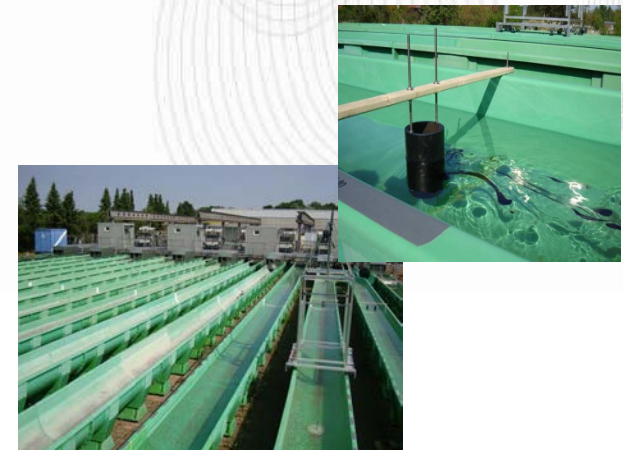
### Static trials at laboratory scale



### Environments: continental waters



Dynamic trials in flume tank



Dynamic trials in man-made river

## Evaluation of hydrocarbon physicochemical behaviour

### Mise à jour des données

Expérience de type cinétique à l'échelle laboratoire

Expérience de type essai à l'échelle laboratoire

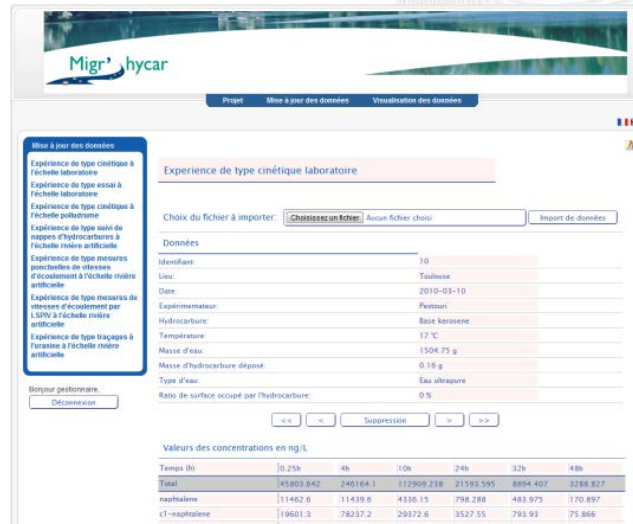
Expérience de type cinétique à l'échelle polludrume

Expérience de type suivi de nappes d'hydrocarbures à l'échelle rivière artificielle

Expérience de type mesures ponctuelles de vitesses d'écoulement à l'échelle rivière artificielle

Expérience de type mesures de vitesses d'écoulement par LSPV à l'échelle rivière artificielle

Expérience de type traçages à l'uranine à l'échelle rivière artificielle



**Migr'hycar**

Projet Mise à jour des données Visualisation des données

**Mise à jour des données**

Expérience de type cinétique à l'échelle laboratoire  
 Expérience de type essai à l'échelle laboratoire  
 Expérience de type cinétique à l'échelle polludrume  
 Expérience de type suivi de nappes d'hydrocarbures à l'échelle rivière artificielle  
 Expérience de type mesures ponctuelles de vitesses d'écoulement à l'échelle rivière artificielle  
 Expérience de type mesures de vitesses d'écoulement par LSPV à l'échelle rivière artificielle  
 Expérience de type traçages à l'uranine à l'échelle rivière artificielle

Expérience de type cinétique laboratoire

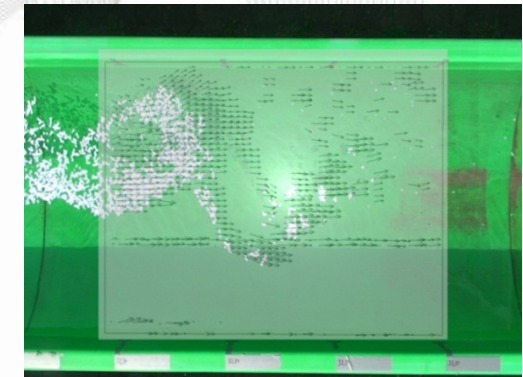
Choix du fichier à importer:  Aucun fichier choisi

Données

Identifiant: 10  
 Lieu: Toulouse  
 Date: 2010-03-10  
 Expérimentateur: Pectun  
 Hydrocarbure: Base kerosene  
 Température: 17 °C  
 Masse d'eau: 1504.75 g  
 Masse d'hydrocarbure déposé: 0.16 g  
 Type d'eau: Eau ultrapure  
 Ratio de surface occupé par l'hydrocarbure: 0 %

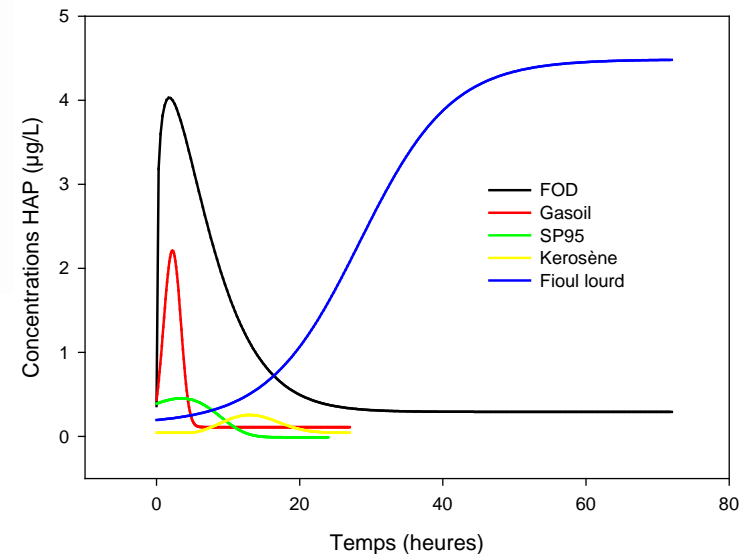
Valeurs des concentrations en ng/L

Temps (h)	0.25h	4h	10h	24h	33h	48h
Total	43803.842	246184.1	222909.238	21293.595	8994.402	3268.827
naphthalene	11482.6	11439.6	4336.15	798.288	481.975	170.897
cl-naphthalene	119601.3	78237.2	298172.6	1527.55	793.93	75.866



- Comprehensive database (products, experimental conditions, hydraulic conditions...)

- Online publishing of database following validation of scientific results

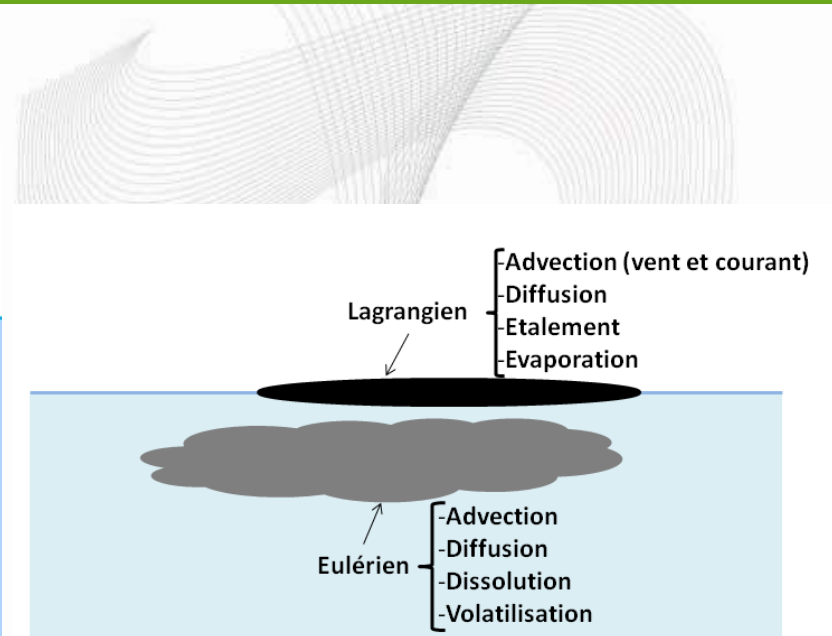
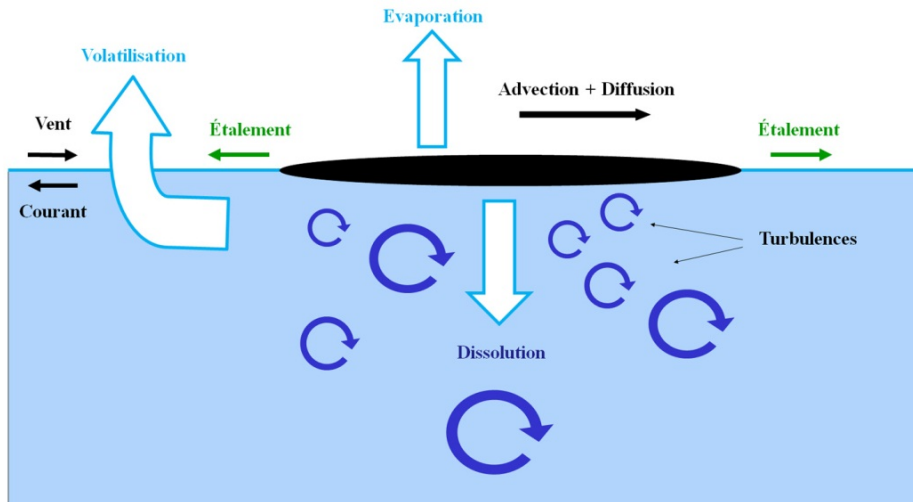


## Deterministic modelling of an oil spill in continental waters

Phénomènes physiques	Temps caractéristiques
convection et diffusion (de la partie dissoute)	heures
dissolution dans la colonne d'eau	heures
convection de la partie flottante	heures
dérive sous l'action du vent	heures
évaporation	heures
échouage sur les berges/îles/ouvrage	heures
effet des ouvrages en travers (barrages, seuils)	heures
dispersion (gouttes en suspension)	jours
division de la nappe/reformation	heures
étalement	heures
émulsion	jours
ré-entraînement de la partie échouée	heures
sédimentation (des gouttes en suspension)	jours-semaines
adsorption par les MES	jours
effets mécanique des vagues/houle	heures
effet de la marée	heures
remise en suspension à partir des sédiments	mois
dépôt sur les sédiments (adsorption)	mois
biodégradation/Dégradation microbienne	mois
photo-oxydation (nappe et partie échouée)	mois



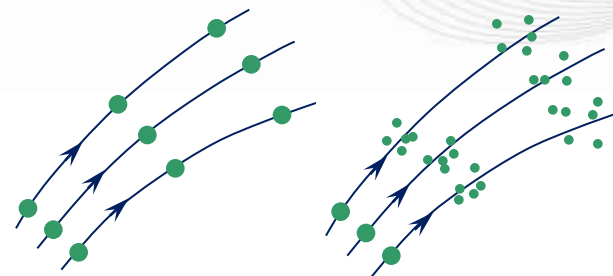
## Considered approach



## Physical processes modelled

- Oil is represented by a cluster of dots
- Turbulent diffusion is modelled by an appropriate stochastic term

## Conceptual model



# Process validation

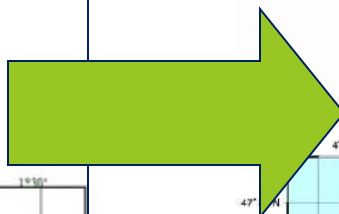
## Application to slick tracking

11 December 1999

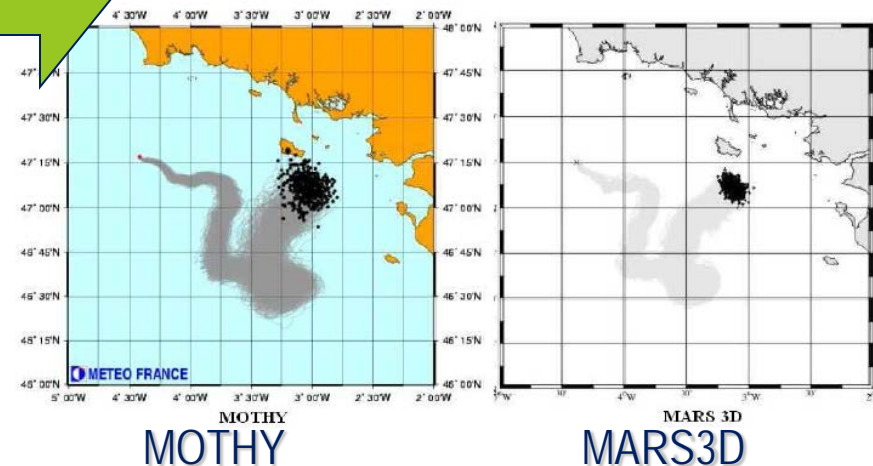
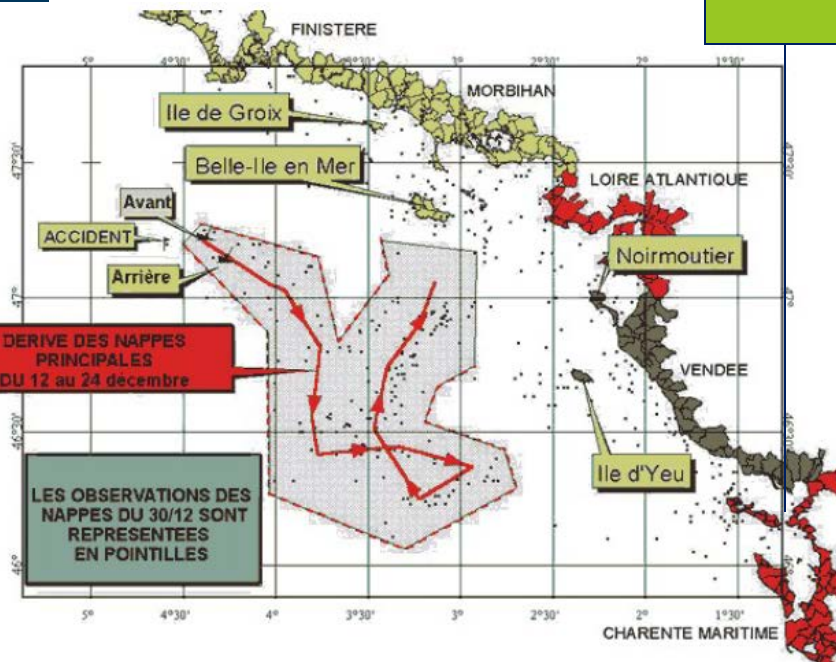
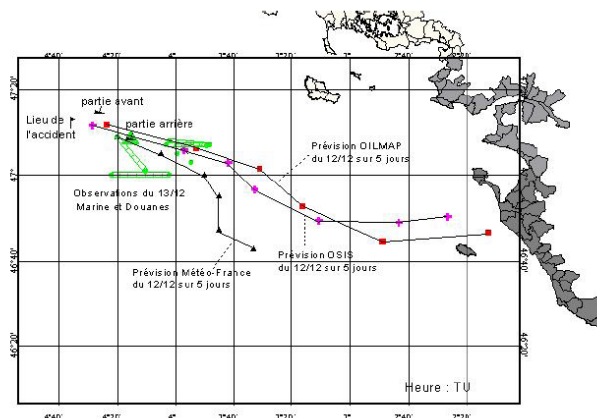


observations

forecasts

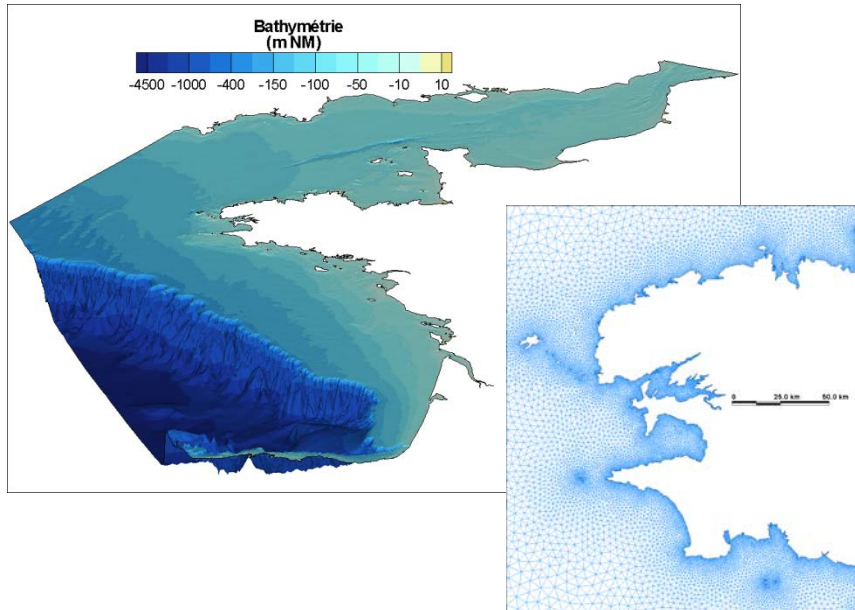


OILMAP, OSIS, MOTHY

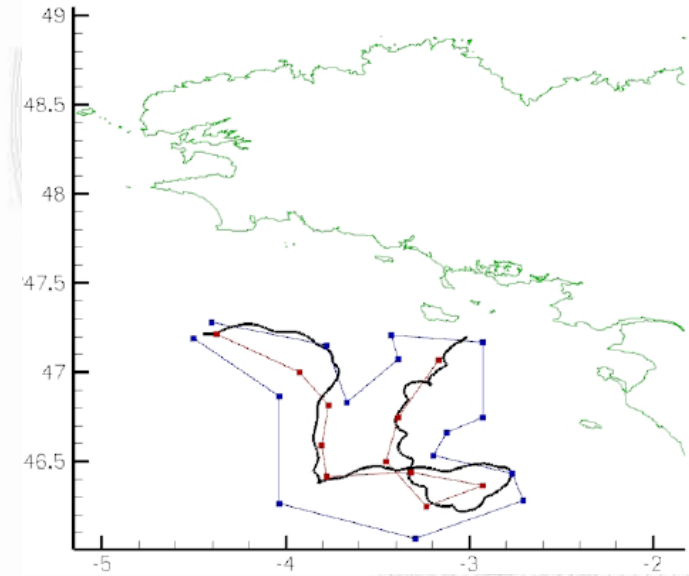


Sources: CEDRE & Liteau report (IFREMER and METEO FRANCE)

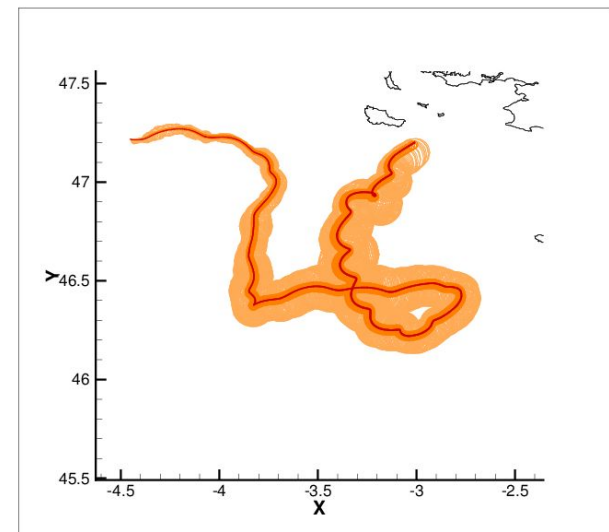
## Surface slick



- Assessment of uncertainties and methodological choices
- Wide spectrum of model applications

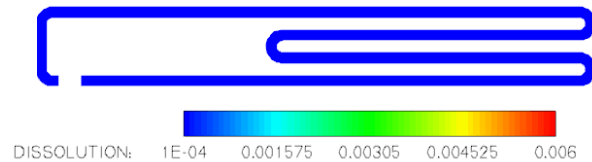
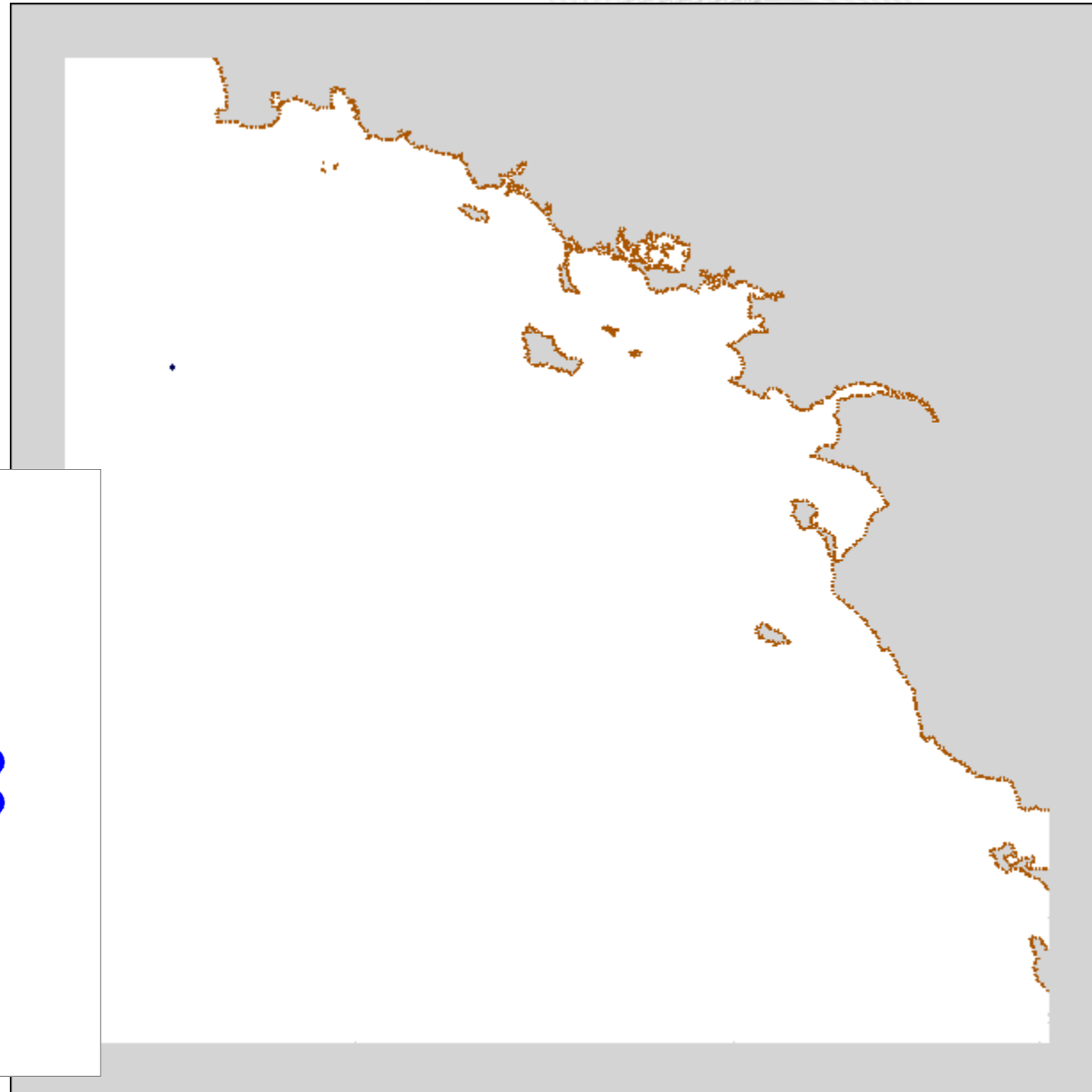


- Validations of surface drift



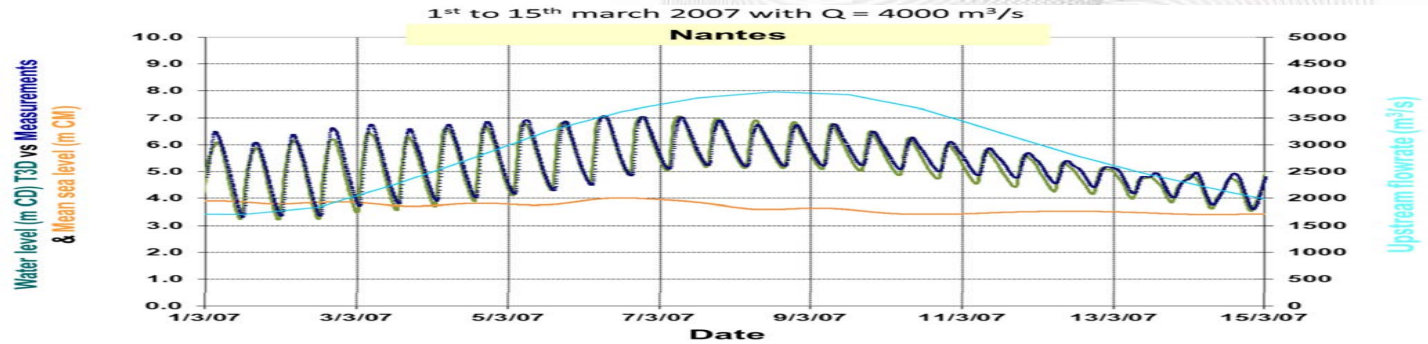
## Animations

- Man-made river
- Coastal area





## Application in an estuarine area



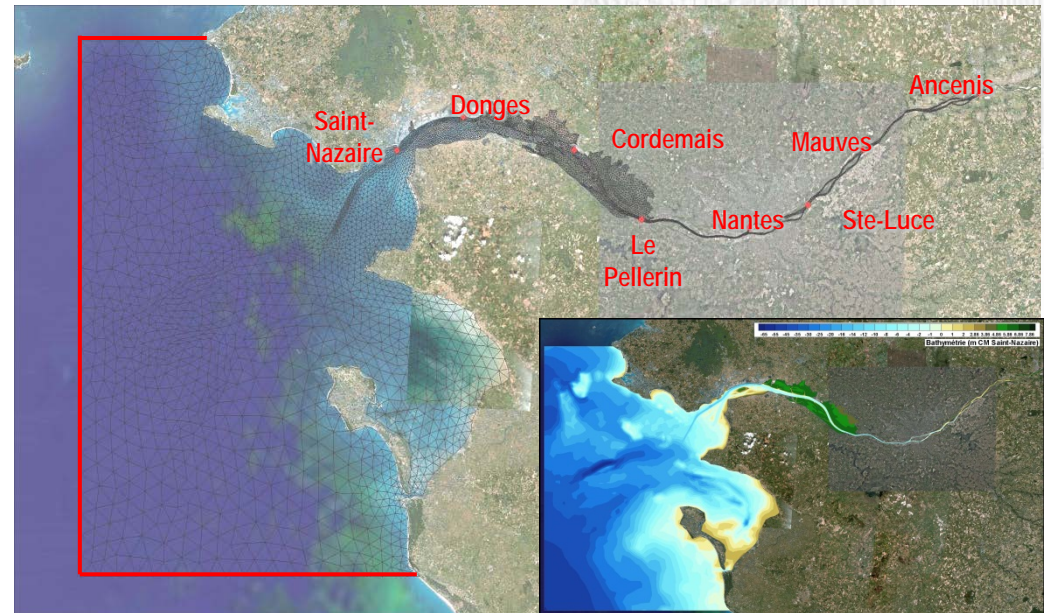
- Use of a 3D model of the Loire estuary
- Hydro-sedimentary model (silt plug, dredging, creation of mudflats...)

40 km in maritime areas

90 km in rivers

130000 calculation nodes

50 m to 2500 m mesh size

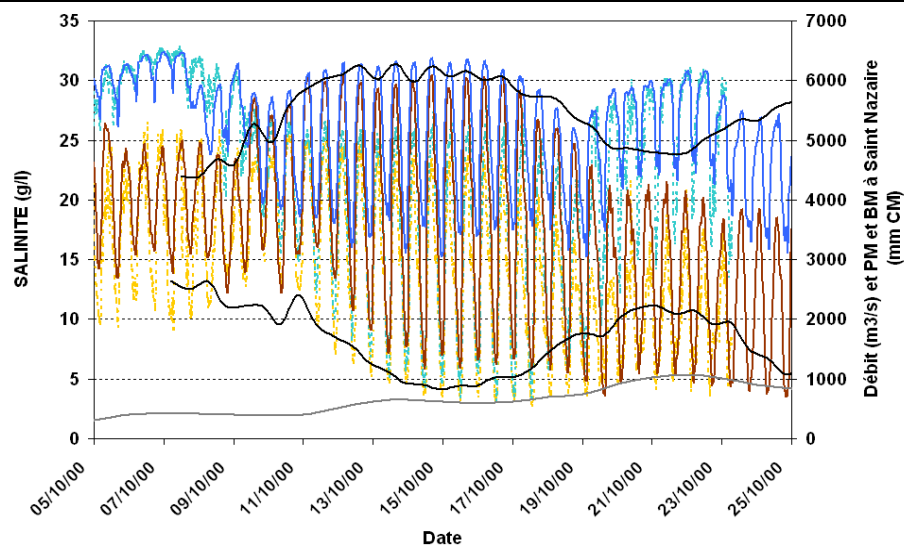


## Complex hydraulics

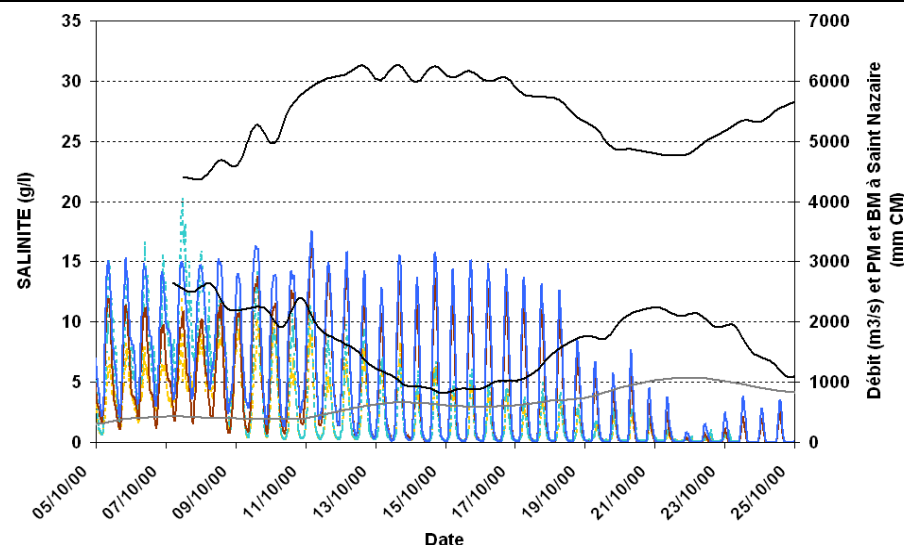
- Strong three-dimensional current system due to seawater intrusion
- Strong vertical stratification of water masses (density currents)
- Complex sedimentary processes



### Montoir



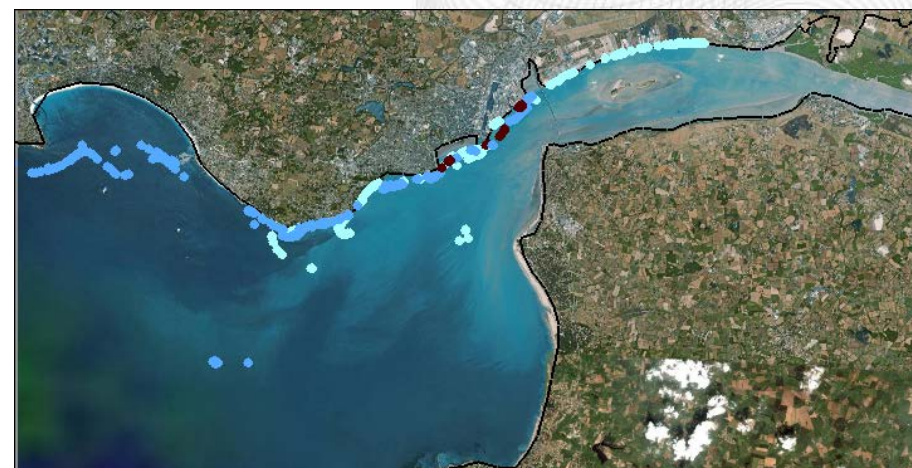
### Cordemais





## The incident and results

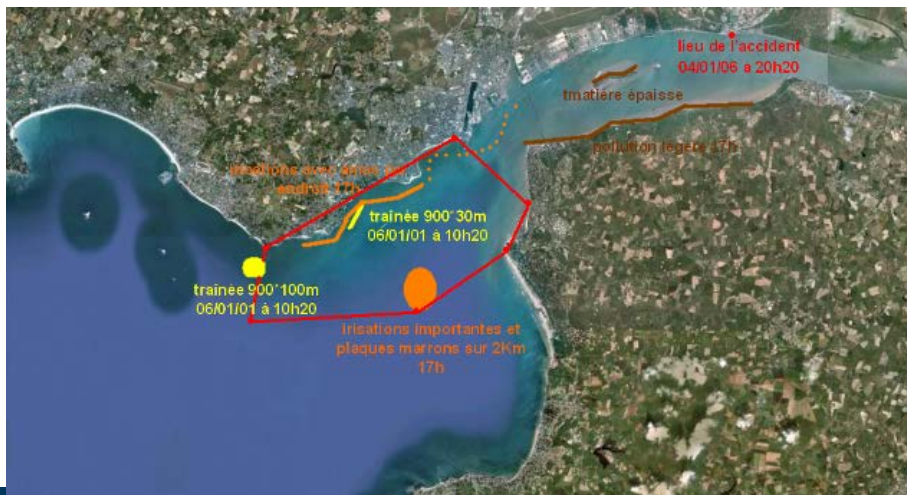
- Damage to steering system on 4th January 2006 downstream of Donges refinery



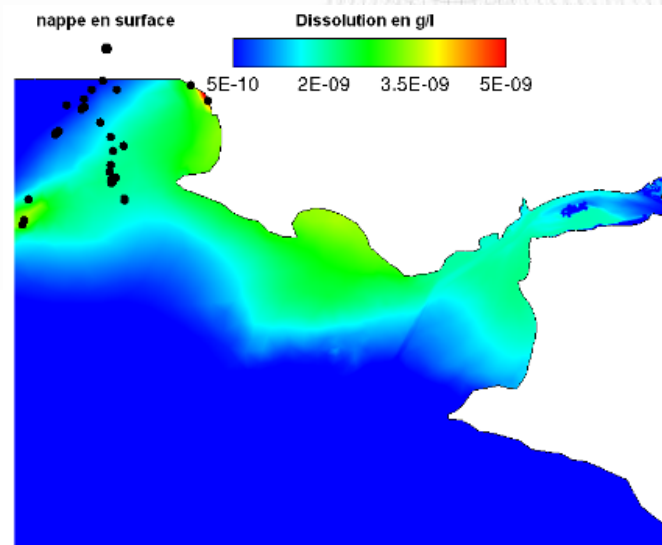
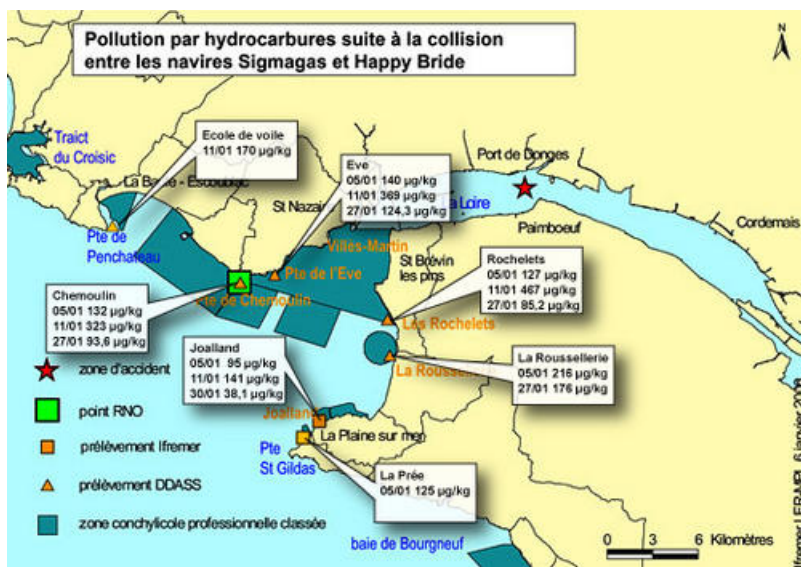
- Observations on land
- Observations in the aquatic environment

- Slick simulated at 17:00
- Oil on shore
- Slick simulated at 11:00

# Results of Loire modelling



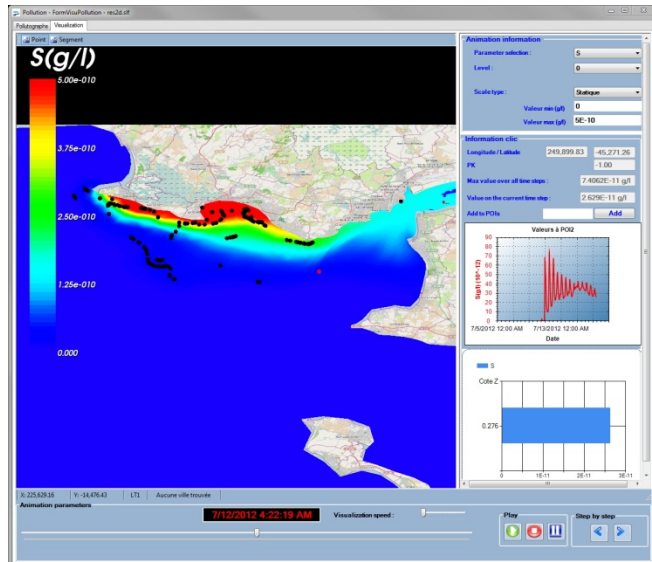
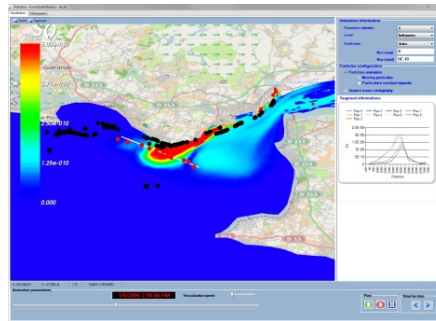
- Qualitative comparison of the concentration of dissolved PAHs (concentration in water g/l -  $\mu$ g in one kg of organisms)





## Development of a user interface for the model

- Development of an interface on pilot sites:
  - Garonne river, south of Toulouse
  - Loire estuary



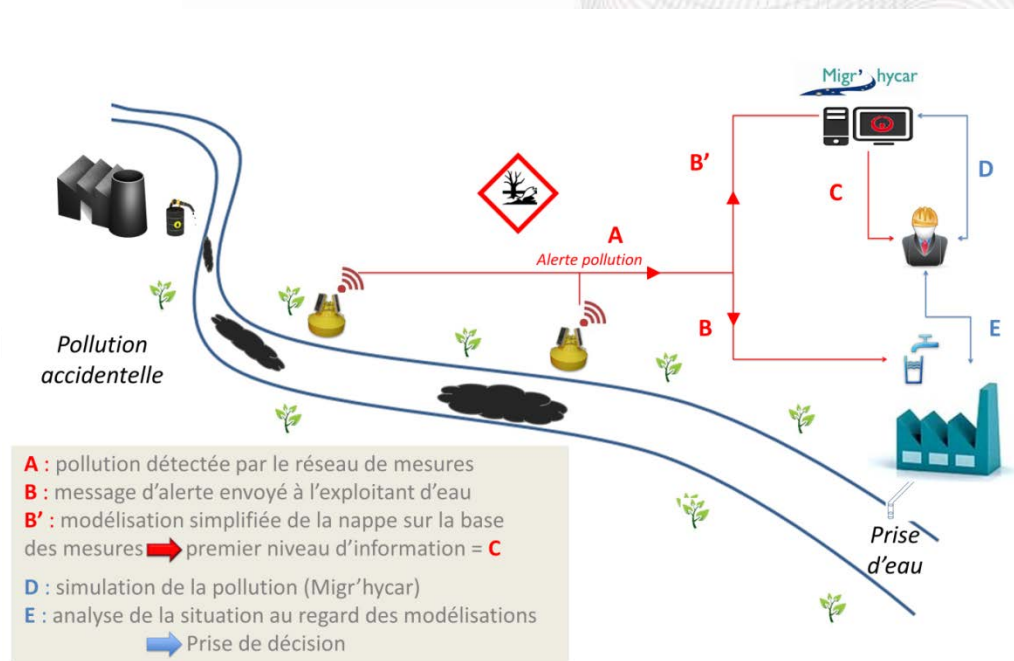
- Pre- and post-processing of the Telemac code "oil" module
- User friendliness and fulfilment of users' needs
- Clear summary of expected risks

## Conclusions

- New database for refined products
- Operational and evolutionary modelling tool
- Use of model on pilot sites (Loire estuary and leak at Pech David drinking water plant, south of Toulouse)
- Development of pre- and post-processing tools

## Future prospects

- Validation of warning system
- Technical and economic analysis
- On site deployment





[www.arteliagroup.com](http://www.arteliagroup.com)