LAGRANGIAN DRIFT APPLIED TO NEARSHORE PLASTIC WASTE : CASE STUDY OF THE REGION OF BAY OF BISCAY-CHANNEL

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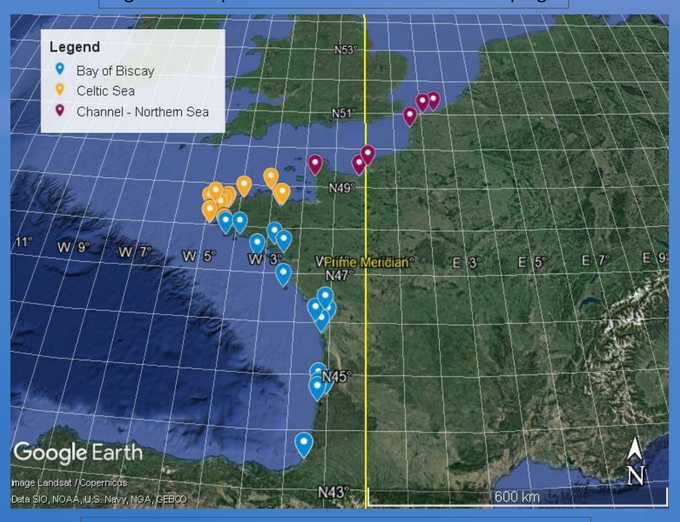
Introduction

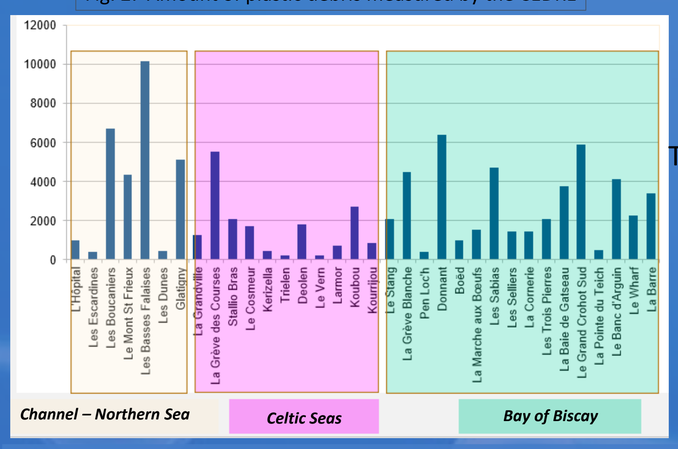
The Bay of Biscay has been identified as a convergence zone for floating plastic particles in different observations[1] and simulated scenarios[2]. In France, the information on plastic waste accumulation is still scarce.

Fig. 1 : Local positions of the CEDRE 2019 campaign



The goal of the CEDRE campaign is to identify the different kinds of waste stranded on 34 beaches along the French coast. During 2019, the CEDRE went several times to the same beach sections to collect all present debris.

Fig. 2: Amount of plastic debris measured by the CEDRE



In the plastic debris collected, the CEDRE identified different objects such as plastic bottles, packaging, or fishing nets. There is a clear accumulation of plastic waste in all these locations.

➔ Observations can be useful information for localized studies. From the numerical models, we can better understand the different factors that drive the particles transport dynamics at larger scale[3,4]. This study is an attempt at working with both observations and numerical simulations to have a complete analysis on the topic of plastic waste accumulation in the marine environment.

Objectives

- **Understanding the influence of ocean circulation on floating debris distribution in the study area**
- **Applying a characterization method to identify the particles paths across the area of study**
- **Comparing the results from numerical simulations to the observations from CEDRE campaign**

Fig. 3: Characterization of types of particles according to their trajectories

Characterization

A) Particles ending at sea (in the ocean grid)
B) Particles ending at coast (beached)
C) Particles that stay along the coast (less than 1 km)

Method

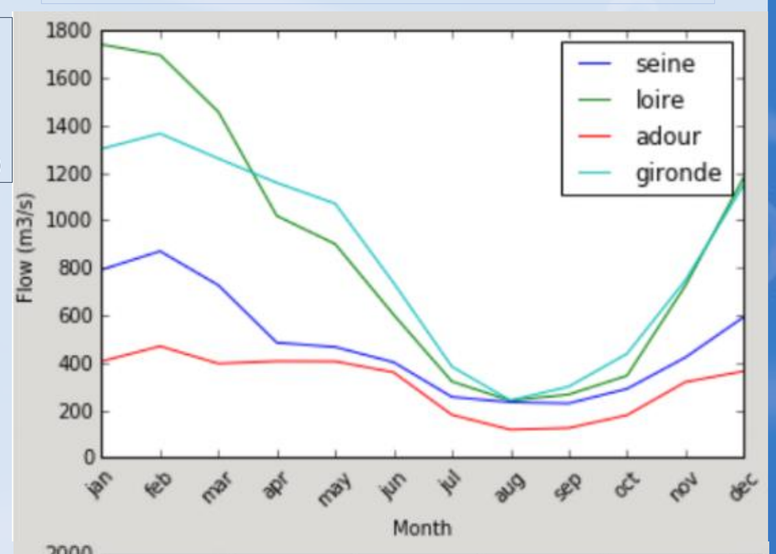
Numerical experiment :

- Lagrangian advection calculator : Ariane (http://mespages.univ-brest.fr/~grima/Ariane/)
- Numerical surface currents field : MARS – 3D[5]
  Resolution : 1 km x 1 km
- Duration : 2001 – 2010
- Output frequency: daily

Initialization

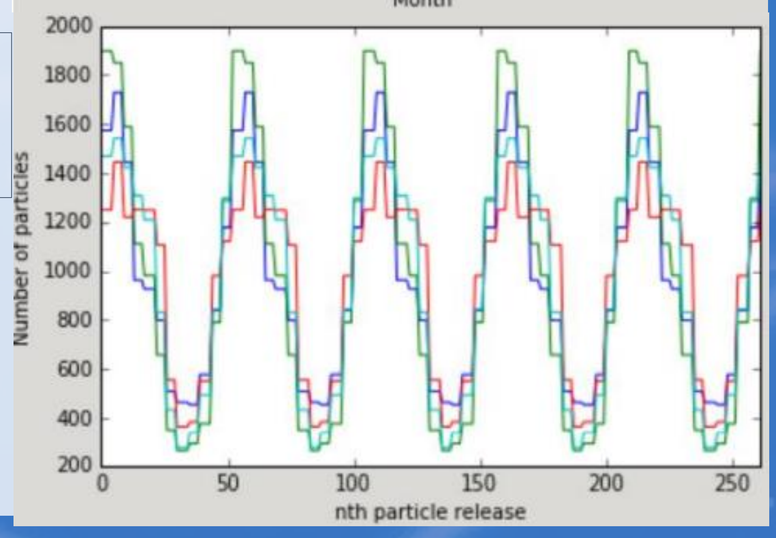
Particles are released weekly during 10 years. At the end of the model simulation, 1 million particles have been released. Initial positions of particles are located at the center of 4 main river estuaries (Loire, Seine, Gironde, Adour), and homogeneously distributed on a 30 km radius.

Fig. 4: Inter-annual flow averages of 4 main rivers (source : BanqueHydro)



The release trend is weighted by the interannual river flow averages. The aim is to have a scenario where the amount of particles in the marine environment is driven by the river input.

Fig. 5: Temporal evolution of the simulated particles input during initialization



Results

43.3 % of particles at sea (433709 particles)
55.7 % of particles beaching (557961 particles)
0.8 % of particles staying along the coast (8334 particles)

Fig. 6: distribution of the beached particles at the end of the Ariane experiment.

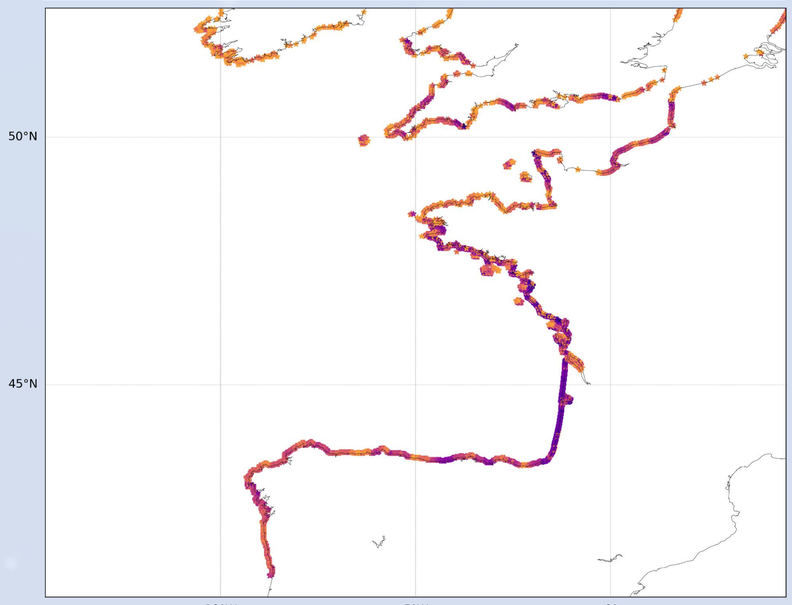


Fig. 7: Spatial distribution of the particles at sea at the end of the Ariane experiment.

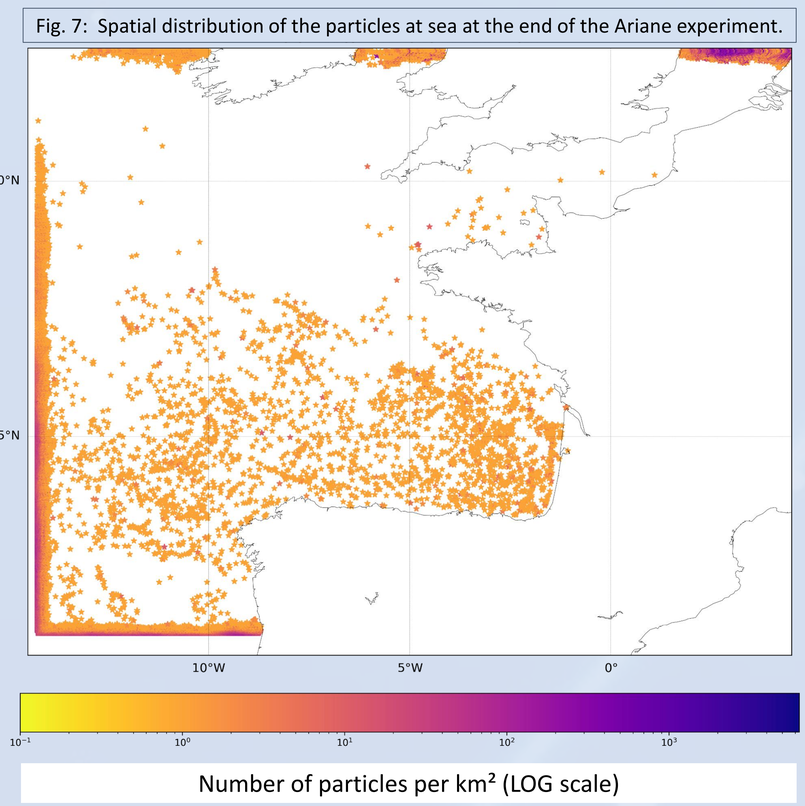
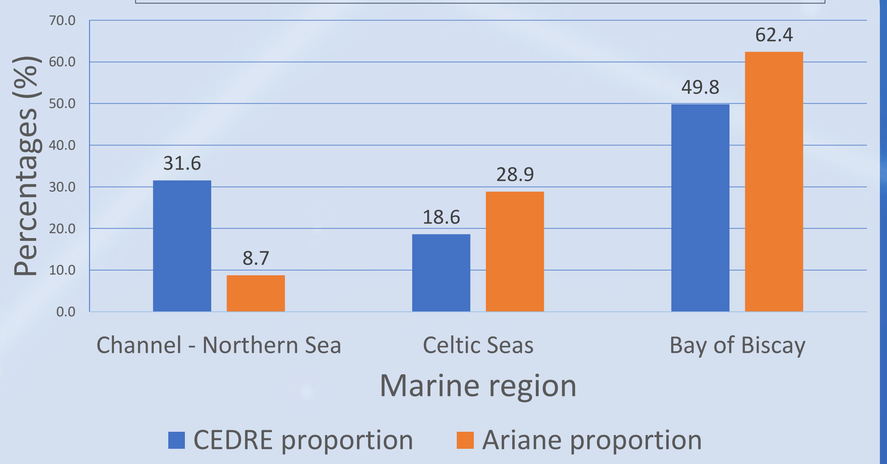


Fig. 8: Percentages of beached particles in our simulation and beached plastic debris from the CEDRE observations in 3 main coastal areas



In the case of particles beaching, the comparison between the CEDRE campaign and our simulated results show similar spatial distribution at the regional scale: the Bay of Biscay appear to accumulate the largest part of particles in our model as well as in the observations.

Discussion

- The transport dynamics seem to be in agreement with the observed data at a regional scale more than a very local scale. The Bay of Biscay appears as a convergence zone for beaching particles compared with the Celtic Sea and the English Channel.
- The observational data show that all beaches in the campaign are impacted by plastic accumulation, while the model results display some local areas without particles.

Conclusion

➔ This study is a first approach of analysis of the plastic waste accumulation phenomenon in the area of the Bay of Biscay and English Channel using a high spatial resolution model simulation and a large volume of simulated particles.

➔ The results confirm that this area is an **accumulation zone** for floating plastic debris, and identify new areas of interest for further work in marine environment monitoring.

➔ Parametrization of the experiment is open to new adjustments. We can take into account :
- Other types of input for the **source term**
- Additionnal **sinking mechanisms**
- New criterion for better describing the **particles paths** along the coast
- Additionnal physical processes affecting particles advection such as the Stokes drift

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